THE

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RAILWAY TRAIN LIGHTING.

A PAPER by Mr. A. H. Bauer, recently read before the American Institute of Electrical Engineers at Chicago, gives some interesting information as to the latest development of train lighting by electricity in the United States. From it we learn that for the past two years, four cars, each equipped with 32 cells of 150 ampère-hours capacity, serving 26 16-C.P. 60-volt lamps, have been running between Chicago and Cincinnati, and Chicago and Indianapolis. Two of these cars are charged daily at Chicago for about nine hours. Previous experience having suggested that course, the cells are not removed from the cars; but the cars are placed at a spot convenient for the purpose, to which cables from the dynamo are led, the proceeding being, in fact, precisely that pursued by the Brighton line, now many years ago, on the first introduction by that company of the light in the Pullman car running between Victoria and Brighton. It is stated that the average time the light is required during what is termed a "round" trip is six hours. When repairs are required, the defective cells are replaced by others. From September, 1891, to January, 1892, inclusive, the cost of repairs and renewals, per month, is said to have been $314—approximately £78—working out at 10 cents per lamp per day. The cost of the engine and boiler is not included, owing to their being employed mainly for other purposes. It is clear, however, that to the 10 cents must be added something, if only for coal. The batteries for the 26 lamps in each car will consume, at least, three horse-power for nine hours per day, and it will be but fair, also, to include something for labour, interest on outlay, wear and tear, and sundries.

In January, 1888, an attempt was made to light two six-car trains, running between Jersey City and Jacksonville, Florida, a distance of 1,100 miles, by a dynamo driven from the axle of one of the vehicles. In America, as we know, the bogie truck is exclusively employed, and this very naturally interposed a serious difficulty, so serious that the idea was abandoned, and in its place a Brotherhood three-cylinder engine and dynamo, bolted to a cast iron bed plate, was provided in the forward end of the baggage car, the engine being served with steam by a flexible tube connected to the tender. The space occupied was 6 feet 6 inches by 3 feet 3 inches. A two-gallon sight-feed pressure lubricator, furnished oil to all parts of the engine, the average consumption of oil being about one gallon for 20 hours' running of engine. An automatic switch placed in the car is arranged to break the circuit when the E.M.F. of the dynamo equals that of the batteries. A voltmeter and ampèremeter, as also a tachometer is provided, so that a complete check can be kept on output and speed. The wiring is apparently the same as that in use on the Midland main line trains, the cables being carried along the top of the vehicles. The

trains upon which this system is employed are vestibule trains, and the three cables of the several vehicles are coupled together inside the hood by means of ordinary couplers formed of square brass tubing. Each car carries 32 cells, 16 in a box, the two boxes being arranged under the centre and directly over the truss-rod. The weight of the batteries and boxes is about 2,000 lbs. The lamp equipment of a six-car Pullman train is as follows :—

Combined smoking and baggage car ...	21 lamps.
Dining car	32 „
Three sleeping cars	90 „
Combined observation and sleeping car	29 „
Total ...	172 lamps.

Of this number 98 are 16-C.P. and 74 are 8-C.P., the latter being used for lighting the toilet-rooms, vestibules, and passages or hall-ways. During some six months of the year, seven one-eighth horse-power fans are used, driven by motors. Each of these absorbs the current of four 16-C.P. lamps, which, added to the 172, makes the total equal to 200 lamps. To maintain these 200 lamps calls for, it is said, 144 ampères, and as the dynamo employed generates but 80, the batteries are called upon for 64. To meet this the batteries are charged up *en route* during the day and part of the night.

Returns furnished show that the total average lamp hours for the round trip, Jersey to Chicago and back, is 3,288.

The cost of such an installation is $5,808.20, or an average of $968 per car. The average cost of labour and material, including wages of five attendants on the train, and two men at each terminal station was, from August, 1890, to February, 1892, $1,265.95—the cost per car per day being $1.99, per lamp 7·17 cents.

The cost of power derived from the locomotive boiler is not included. It is added that, during the coldest part of the winter, or, as sometimes happens, when a poor quality of coal is furnished, it is difficult for the locomotive to supply sufficient steam to run the dynamo. The batteries have then to be relied upon, and, as a rule, they are able to do so for about four hours.

The same method of lighting is also in use on trains between New Orleans and the City of Mexico, Omaha and San Francisco, Chicago and Portland.

Mr. Bauer, in conclusion, expresses the opinion that the ideal way of driving the dynamo is by connection with the axle. We are very much in accord with him here. All the trains which have been lighted electrically on the Brighton line have obtained the motive power from that source. Most of the trains on the Midland Railway follow the same course. Some four others, as we have learnt from Mr. Langdon, are worked from an auxiliary engine placed upon the locomotive, but what success has attended the experiment we are unable to say. The lighting of the trains has continued, but whether the results, regarded from a working point of view, are such as to indicate an extension in that direction is not yet made clear. At the same time we see no difficulty provided the arrangement is encouraged by the locomotive engineer and generally supported by his staff. If the electrical gear is regarded as intrusive; if it has to be dealt with independent of the locomotive department by another department of the service; if, in fact, the thing cannot be welcomed and so harmoniously worked between the two branches of the service as to insure the most devoted effort on the part of both to effect the result required in the company's interest, and for the comfort and convenience of the travelling public, we are afraid that to rely upon the locomotive as the direct source of power will not ultimately prove successful. It could possibly be made so by the exercise of authority on the part of the board of management, but to do so would probably be felt to relieve other quarters of a responsibility which it is not desirable should be interfered with. There is, of course, a difference between the provision of the auxiliary engine and its dynamo in the baggage or guard's van and placing it upon the locomotive. In the first place it is, when in the van, independent of the locomotive except as regards steam. It is within easy reach, can easily be examined and controlled. On the locomotive, as so far arranged on English lines, the apparatus has not found a fair and reasonable resting place, a place easily accessible to the man who has to see to it; nor, unless the locomotive engineer bends his mind towards its accomplishment, is it likely to do so. If, therefore, the Midland experiment is being attended with any degree of success, it must be due either to the Midland locomotive engineer putting his shoulder to the wheel, or to indomitable perseverance and attention on the part of the electrical staff.

Driving from an engine is undoubtedly more simple than driving from the axle. In the former we get regularity of speed and direction, in the latter the reverse. But the automatic arrangements evolved by those who have devoted so much time to the subject have practically overcome difficulties consequent upon speed and direction, leaving but the belt question to settle. Driving by short belts is no doubt a troublesome question, and productive of much attention. This, however, should not be insurmountable. If our trains are to be lighted electrically—and this, we feel, will be the case in the long run—surely railway companies, who are daily adding to their rolling stock, can construct a vehicle that shall afford the requisite convenience for a reliable drive from belting. On the whole, we are inclined to think the axle will be found to afford the most convenient results—*i.e.*, of course, unless locomotives are constructed to carry a dynamo and small auxiliary engine in a convenient position, and the locomotive department earnestly takes up and fosters the subject. There is, however, one other way in which the subject has not yet been treated. That is, the use of vans or cars provided specially for the lighting apparatus, and which might at the same time accommodate luggage, but which should be constructed mainly for driving the electrical apparatus. The construction of such a vehicle would not be very costly; it would at once get rid of much of the inconvenience which always attends the imposition of new, or additional apparatus, upon that which has been designed entirely for other purposes, and for its own purposes only.

Mr. Bauer will, we fear, at times experience difficulty, as his paper suggests, when dependent under all circumstances upon the locomotive. The locomotive or an independent boiler, however, would appear to be his only resource, barring our suggestion above, for much difficulty must attend the application of driving gear to bogie vehicles.

The electric lighting of railway trains must in many parts of the world become a necessity—not merely as a matter of economy to the management, but as one of comfort and convenience for travellers. In England its progress may be slow, but few will doubt its ultimate entire adoption to the

prejudice of gas. The beauty and purity of its light, together with its many other advantages, will at all times favourably compare with any illuminant of the day. Competition will do the rest.

THE CANDLE-POWER OF INCANDESCENT LAMPS.

IN a recent issue of an American contemporary, we notice an article on the candle-power of incandescent lamps, which calls attention to the want of some settled standard for the light-giving power of such lamps, and for the method of measuring the same. The writer of this article does not appear to have a very high opinion of many American lamps, as he says that the so-called and labelled 16 candle-power lamp, which has been adopted as the standard, has been found to vary from 8 to 18 candle-power, and to consume from 2½ to 8 watts per candle; and, further, that American lamp manufacturers seem to divide lamps into two classes, viz., a high efficiency short-lived lamp for use when current is supplied by contract, and a low efficiency, but more durable lamp, for use when current is supplied by meter, and it is suggested that these are supplied to central station managers, and through them to their customers, according to the method in which the current is charged for. If any such practice as this can be carried out, it would appear as if that particular commodity called "cuteness," with which Americans are generally credited, must be the subject of a monopoly owned by the lamp manufacturer and station manager. In England, although we have unfortunately to pay a much higher price for our lamps, we have at any rate escaped such inflictions as a so-called 16 candle-power lamp giving only 8 candles at about 8 watts per candle-power; and this is no doubt due in great measure to the fact that as only one type of lamp can be used, the non-technical user has reaped the benefit of the efforts of those who, having the opportunity of testing lamps, have kept the manufacturers up to the mark by insisting on getting lamps of good quality as a set-off to the high price charged for them. The possibility of a falling off in quality occurring at the same time as the expected decrease in price when the present monopoly expires, is a point which will require attention, and in view of this any improvements in the method of comparing different lamps will be very welcome. As regards one point which is liable to create a good deal of confusion as to the relative values of the illuminating powers of different lamps, namely, the unequal distribution of the light due to the shape of the filament, the author of the article we have referred to states that good results have been obtained by mounting the lamp in a socket, which can be revolved on its axis at about 300 revolutions per minute, so as to get a measure of the mean horizontal illuminating power; and it would be interesting to know if any experimenters in England have tried this method, which, if it can be conveniently carried out, would be a great improvement on the more tedious plan of measuring the candle-power of the light emitted at various angles in the horizontal plane.

Selective Signals in Telephony.

AN interesting and full paper on this subject was recently read by Mr. T. D. Lockwood, before the American Institute of Electrical Engineers, Chicago. The question dealt with is that relating to what is generally known as "Individual Call" apparatus, descriptions of various forms of which have appeared from time to time in the pages of the REVIEW. It is pointed out by Mr. Lockwood that the rapid extension of telephonic communication seems to indicate that some forms of individual calls must be adopted, if a limit to the endless multiplication of wires becomes necessary. It is a somewhat curious fact that although England, as regards telephonic communication, does not stand by any means to the front in point of numbers of subscribers when compared with population, nor is credited with being in the front as regards inventive genius, has, nevertheless, been the pioneer as regards invention on the individual call system. Mr. Lockwood, in commencing his historical sketch of the subject says:—"The idea of producing a practical selective signal is not (as might, from the introductory remarks of this paper, have been supposed) one which made its first appearance subsequent to the advent of the telephone. Appliances possessing the same characteristics appeared in England many years ago, and several forms have from time to time been patented in this country for use in connection with telegraphy, which closely resemble some of the forms which, within the last 10 or 12 years, have been reinvented and patented here." In spite of this spirit of invention, the use of individual calls is practically nil, a fact which is probably largely due to distrust in the working of such apparatus, and the more certain security which is given by a multiplicity of wires, a multiplicity which, in this country at least, has not become really excessive.

Electric Railways.

THE ninth general meeting of the American Institute of Electrical Engineers was held at Chicago from June 6th to 8th, under the chairmanship of Lieutenant Frank J. Sprague. The presidential address is entitled "Coming Development of Electric Railways." The keynote of the paper is caution. We agree with Mr. Sprague that in future no overhead line should be erected, except where it is justified by the conditions of traffic; and that in every case the feeders should be laid underground. The latter arrangement reduces the risks and unsightliness to a minimum, and with it there is probably little real objection to the trolley system for suburban traffic.

Motor Generators for Electric Tramcar Propulsion.

Mr. H. WARD LEONARD has proposed an ingenious arrangement for trolley cars, which, theoretically at any rate, obviates the necessity of a variable speed reduction. The series wound electric motor, although possessing many advantages, is undoubtedly very inefficient at starting, and also when running at slow speeds; and, unfortunately, both of these conditions must frequently occur with tramcars in towns. To overcome these drawbacks different forms of variable speed gear have been tried; but from complication of parts, noise, and unreliability, have never proved successful. The point aimed at by all inventors in this field is to keep the motor torque and speed practically constant, and to vary the ratio of gear reduction. Mr. Leonard proposes to accomplish this end by using a continuous current converter, the motor part running as a shunt motor across the mains, and the dynamo *field* being excited also off the mains, through a variable resistance. The working, or propelling motor of the car, will be shunt wound, and the field coils will be excited with a constant current from the mains, while the armature will be coupled in series with the generator armature of the converter. The regulation of the secondary

current is easily effected by the variable resistance, and the generator thus supplies current to the propelling motor according to the torque required. Electrically nothing could be more simple; but practically there are mechanical difficulties to be feared, not to mention for the moment the probable increase in the cost of the plant. The scheme requires at least three shunt wound high tension machines per car, each sufficiently large to give the maximum horse-power required for the work, and it may reasonably be doubted whether the advantages to be gained are sufficient to warrant such a multiplication of machines on the cars.

Electric Launches at the World's Fair.

THERE seems to be some doubt as to whether electric launches will be used at the coming Chicago Exhibition. A trial between steam and electric launches was arranged for June 1st last; but only one electric boat, that of the Columbian Company, was ready for the test. This made the trial trip on a rough sea, but from all accounts behaved admirably, and both the builders and the storage battery manufacturers were loud in praise of her. The accumulator is supplied by the American Battery Company. It is the invention of William Morrison, of Des Moines, Ia., and, strictly speaking, is simply a modified Planté cell. The peculiarity lies in the construction of the plates, which are made of pure strip lead ⅜-inch in width, bent so as to make parallel layers. The forming takes about 10 hours, and ultimately when the plates are completely formed about one-half of the lead is oxidised. There does not seem to be any point of great novelty, and we should be surprised to hear of any very startling results. However, the makers state the capacity of a 37-pound cell to be 200 ampère hours. We hope it is so. The motor of the Columbian launch is a 5 horse-power Jenney motor placed under the aft-deck. The propeller, which is 24 inches in diameter, is, as usual, now coupled direct to the motor shaft. The cells are 104 in number, and by a suitable switch can be coupled in two, four, or eight parallels. Generally the arrangement appears to be very similar to that adopted in England.

Chicago and St. Louis Electrical Express Line.

A LECTURE was recently delivered by Dr. Wellington Adams on an electrical express line now being built between Chicago and St. Louis. The new railway presents several features of novelty, and the result will be eagerly waited for by the whole profession. To begin with, the track is on a *bee* line between the two cities, and the speed is to average 100 miles an hour, *i.e.*, trains will cover the 250 miles in two hours and a half. The maximum grades are 2 per cent., and these chiefly occur at points where it is necessary to raise the line over steam or highway crossings. But in general the track is made level, and the roads are led over it by suitable inclines, this arrangement being found to be much cheaper. The permanent way is to be extra solidly built and ballasted with stone only, and the metals will be of the California type, which obviates the ordinary fish plates and joints. The cars have long sloping heads, and seem admirably adapted for the work. They are mounted on two bogies, each having a 200 H.P. gearless motor attached to it. The chief point of interest to our readers will be in the electrical system of distribution. The details are not yet fully published, but we gather that the scheme involves multiphase currents, and is generally as follows:—There will be two power stations, each about 75 miles from one of the two termini. One of these stations is located at a coal mine, the other near a large natural water power. Each station will supply power to one half of the line, in two sections; so that the whole track will be divided into four main sections, each of which will be again subdivided into 10 mile lengths. The dynamos will be similar to those used for the Frankfort Lauffen transmission plant, and will run at 500 volts. The power will be transformed up to 25,000 volts, and then carried by the transmission mains to the sub-stations, where it will be transformed down to 3,000 volts, at which tension the trolley wire will be served. The point, perhaps, of chief interest, is the use of two wires only. How this is to be accomplished is not stated, but Dr. Wellington Adams says they have a complete system. We await the result, and congratulate the Doctor and his colleagues on the pluck and energy they have shown in overcoming strong prejudices and other obstacles placed in the way of the scheme. We cannot help thinking, however, that the thinly veiled spirit of incredulity with which Prof. George Forbes viewed the scheme was perfectly justified.

Note on the propagation of Electric Oscillations.

THOSE who follow up the proceedings of the Paris Academy of Science will be aware of the important contributions to our knowledge of electricity which have been made from time to time by Mons. H. Ponicaré. During the last four months he has been studying the theory of the propagation of the "Hertz oscillations," along an indefinitely produced wire, with the idea of observing whether Hertz's theory takes account of the "dying away" of the waves, which has been noticed by Mons. Blondlot. Since the mathematics of the theory become over complicated when this is taken account of, Mons. Ponicaré has proceeded to the consideration of it in a somewhat indirect way. He commences by supposing that the "dying away" of the oscillations is *nil*, and then deduces the consequences of this assumption; and by supposing the wire to be indefinitely prolonged, he has succeeded in eliminating from the problem several conflicting consequences which only add to the difficulty; but then it becomes necessary to take account of the diameter of the wire. The mathematical consideration of the question was recently given in the form of a paper before the physical section of the Academy of Science, and whilst it can scarcely be admitted into these columns in full, owing to its somewhat abstruse nature, it may interest some of our readers to know that it may be consulted in the *Comptes Rendus*, Vol. cxiv., pp. 1,229—1,233.

Electricity in the Laboratory.

No one should think of employing thermopiles and galvanic batteries in connection with laboratory work when current from dynamos is available, as the latter is far superior for all general purposes. Of course, the current will usually have to be reduced, and for this purpose resistance coils are unsuitable because they are liable to be attacked by the fumes which are generally to be found lingering about in the atmosphere of the laboratory. "Blackened lamps," which are no longer available for illumination, form, perhaps, the cheapest and best means of obtaining the necessary resistance; and it should be remembered that the older patterns have a lower resistance than those of recent manufacture. It is also well to bear in mind the obvious fact that the resistance changes with the temperature, *e.g.*, a lamp of 127 ohms, when cold, has been found to give only 36·6 ohms resistance at white heat, and, again, the resistance of two lamps of equal resistance when hot when arranged in series (110 volts current) is greater than twice the resistance of one. The current may be measured most conveniently, perhaps, in the laboratory by the amount of electrolytic gas afforded per minute. Roughly speaking, 10 cc. gas is equivalent to one ampère (more exactly 1 cc. = 0·0958 ampère). Further particulars concerning the use of the electric light current in connection with laboratory work may be found in a paper by Stillwell and Austin, *vide Journ. Anal. and Appl. Chem.*, vi., p. 129.

LORD DURHAM'S ELECTRIC MINING INSTALLATION.*

BY D. SELBY BIGGE.

THE author thinks that perhaps a description of an electric mining installation, recently laid down by him at one of the Earl of Durham's collieries, may be of interest. The plant is probably the largest and most complete in this country, and is used for performing several of the most important operations necessary in colliery work. The generating plant is situated at the bank, and the power conveyed to a very considerable distance underground, where the several machines are situated.

The engines used for driving the generating dynamos are of the well-known Willans high-speed type, and are two in number, each being capable of developing 140 indicated horse-power at a speed of 380 revolutions per minute, with a steam pressure of 90 lbs. per square inch.

Each engine has two cylinders, 17 inches in diameter, with a stroke of 8 inches, the cranks being set at 180° to one another.

This type of engine was selected—first, because on account of their high speed the engines are very small for the power developed, and consequently the space occupied is much smaller than with slow speed engines. Secondly, because the plant can be readily extended by putting down similar engines, driving additional dynamos, without altering the general design of the generating plant. Thirdly, because owing to the method of lubrication by enclosing the cranks and moving parts in an oil bath they require exceptionally little attention, and all moving parts being enclosed in a case they are particularly suited to places, where, as at a colliery, there is much dust. Fourthly, because extended experience has shown that they are pre-eminently suited for driving electric machinery, and for running for long periods without stopping. The engines are placed at either end of a length of shafting, which they drive through clutches.

From the pulleys on this shaft the dynamos are driven by means of leather link belts, the belt for the power dynamos being 18 inches wide, while a 6-inch belt is used for the lighting dynamo. The larger belts are flat, but are made up of three smaller belts hinged together, so that the whole belt bends to suit the slight curvature given to the face of the pulleys to keep the belt running on the centre. There are two power dynamos, each capable of giving 80 ampères at a pressure of 780 volts, when running at a speed of 500 revolutions per minute. This is equivalent to an output of 84 electrical horse-power each. They are separately excited or magnetised by a small dynamo, which is also used for lighting purposes, giving 90 ampères at a pressure of 100 volts and a speed of 1,200 revolutions per minute, a fourth dynamo giving 120 ampères at a pressure of 100 volts is provided for lighting and exciting purposes, and acts as a reserve to the above.

All four dynamos are mounted on slide-rail foundations, with screws for tightening the belts.

As the two power-dynamos feed into the same pair of main cables it is necessary that the pressure given by them should be the same, and capable of regulation; this is effected by varying the magnetising currents passing round the magnets of each machine by means of resistances fixed on the main switchboards.

The power dynamos are of the well-known Goolden mining type; the armatures are Gramme wound, each wire being securely fixed in position by means of keys in the armature-core. The terminals to which both the exciting and high-tension currents are brought are enclosed in metal boxes, so that they cannot be touched.

The current from these dynamos is first taken to the switchboard where, after passing through the ammeters, one of which (as well as a voltmeter) is provided for each, it passes through the main switches, which connect it to the automatic switch controlling the safety cable as described above. These main switches are double-pole, of the lever pattern, and are enclosed in insulated covers, so that the metal part cannot be touched; double-pole fusible cut-outs are also provided.

From the automatic switch the current passes into the mains, which are taken down the shaft and run a distance of 387 yards from the dynamos to a distributing centre. This portion of the line is equivalent in area to a 19/14 cable, though, owing to the construction of the safety cable, which is used throughout, a greater number of smaller wires are used.

The cable here branches of cast-iron junction boxes, provided with gas-tight covers and clamp terminals inside, being used to effect the connection, and a cable equivalent to a 7/16 is run for another 670 yards to the pump. This distance will be ultimately extended as the water recedes, and the pump is removed farther down the dip.

On the other circuit a cable equivalent to a 19/16 is run a distance of 1,290 yards to the hauling engine, and then a further distance of 1,500 yards to the winding engine.

The cables throughout are of the Atkinson patent safety pattern, described above, and are insulated with two layers of pure India-rubber tape, wrapped in opposite directions (Lord Durham's engineers considering that as the pit was perfectly dry it was unnecessary to go to the expense of vulcanised rubber), and then covered with compounded hemp braiding. They are carried on porcelain insulators fixed to the timbers or roof, being run on opposite sides of the road.

As it was impossible to make soldered joints, the lengths of cable are connected by means of terminals fixed on a slate base, enclosed in cast iron boxes.

Switches which can be opened without the slightest sparking, are fixed at the distributing centre to cut off either of the branch cables, and at the hauling engine to cut off the cable running down to the winding engine.

The pump is of the Goolden standard mining pattern, and is capable of lifting 150 gallons per minute, 270 feet vertical lift, through 6-inch pipes. It is a three-throw ram pump with 6-inch rams, 8-inch stroke. The rams are cast-iron, but the cylinders are fitted with phosphor bronze bushes. Heavy slipper guides are provided to take the thrust of the connecting rods. The motor is a 24 horse-power Goolden mining pattern, and is mounted on an extension of the cast iron bed of the pump (so that the whole can be moved together) and drives the pump through two sets of cast iron gearing with double helical teeth.

The motor is stopped and started slowly by means of a Goolden non-sparking switch, which at starting gradually cuts out resistances, and on stopping re-inserts them. The switch is, of course, enclosed in a strong cast iron gas-tight case.

Here, both on the switchboard and the motor, as at the dynamo, all the terminals and connections are entirely enclosed in metal boxes, so that they cannot be accidentally touched, and although as long as the insulation of the mains and machines is maintained no shock can be experienced by touching one terminal only, yet experience has shown that the slightest shock frightens the men, so that they do not attend properly to the machinery.

The electric hauling engine is for continuous haulage, and is capable of running the rope at a speed of four miles per hour. The machine consists of a strong cast iron bed, which carries the motor and gearing. The motor develops 40 brake horse-power at a speed of 650 revolutions per minute, is of the Goolden patent enclosed type, as described above; it drives a clip pulley (Hurd patent), five feet diameter, through two sets of cast iron gearing with double helical teeth. A clip pulley is used in preference to a coned drum, as by the use of this particular clip the wear on the ropes is considerably reduced, there being absolutely no slip, and as the clip grips the rope almost all round it is not crushed or cut.

The winding engine resembles the hauling gear in general design, the clip pulley, however, is replaced by a drum, four feet diameter, divided in the centre by a flange. It is fitted with a brake drum cast on to it, and turned; the brake strap of iron, without wood blocks, is controlled by a hand lever behind the motor.

The switch for starting, stopping, reversing, and regulating the speed is actuated by an exactly similar lever. The man stands on the foot plate, which is fitted with a wooden platform carried on insulators, and has complete control over the machine with both levers ready to hand. Both levers play over notched segments with the usual snap lock.

The brushes being made of carbon can be run backwards or forwards without any sparking, and in fact no lead either

* Abstract of a paper read before the North of England Institute of Mining and Mechanical Engineers.

way is given or necessary. This is a most important point, as the brushes consequently require little or no attention.

This engine is for winding up a staple, 144 feet deep, raising about 10 cwt. of coal at each lift.

The motor can develop 32 brake horse-power at full load, but the load for lifting is considerably less.

ELECTROCUTION: MORE SENTIMENTALISM.

WE thought we had done with all the mawkish sentimentalism which has signalled the introduction of capital punishment by electrocution, but a new phase of it has turned up. In a recent issue of the *Electrical Age* (New York), Mr. John M. Batchelor suggests a "grave subject for serious consideration" by all electrical mechanicians. "Public hangmen," we are told, "are shunned by the community; the profession they are engaged in is not generally deemed sufficiently respectable to permit intimate social relations with them. The scaffold and the guillotine are likewise objects of horror and repugnance to all well-balanced people; as is the case with the public executioner's axe and block and all other similar paraphernalia devoted to carrying out the mandates of the law in the shape of public executions. Now, in consequence of this universal feeling, the question seriously arises: can electricians as a body afford to encourage or in any way abet the use of electricity which the State of New York has made lawful for the execution of criminals? If such encouragement is given, would not the natural tendency be to create a popular feeling of horror, or, at best, disgust at a means which is associated with one of the most painful so-called necessities of the times?"

"This issue is now in its infancy, and the number of electrical executions are comparatively few, therefore any possible prejudice has not yet had an opportunity for serious development; at the same time let any one to-day ask a lady what she thinks of electricity being used for executing criminals, and she will undoubtedly reply that it gives her a nervous horror to think of it, and she strongly desires to avoid the subject."

Mr. Batchelor argues that the electrical business is dependent upon its popularity as well as upon its money-saving attributes, and, noting that the press, which was at first all but universal in its condemnation of the use of electricity for carrying out the death penalty, in consequence of a supposed torture connected with it, has now undergone a change of sentiment, he recognises in this new attitude "a danger threatening future electrical development." He says: "The effect of so united an action may be easily conceived; for ladies would be likely, in looking at the incandescent lights put into their homes, to consider them as being objects suggesting fearful suffering; as objects to be shunned, like the executioner's apparatus; and in time the remainder of the community would more or less be affected in a like manner."

He goes on to say, "It must not be forgotten that the popular use of electricity is yet in its infancy, and that the struggle to introduce its manifold uses is hard enough at best, in consequence of the newness of the idea. That particular remembered, and the enormous amount of money already invested in allied industries, as well as the sums in contemplation which capitalists will be called upon to meet, should be a sufficient incentive to all electricians to "sit down" upon and in every way discourage the use of electricity in any such injurious manner. The feeling induced by rare accidents is already sufficient to cause insurmountable obstacles against the general use of electricity; as is well known in the case of legislative consent to the extension of business in needed departments. Then shall this legislative obstruction be made worse through any additional incitation on the part of the public, because in the minds of those unable to make proper distinctions it is looked upon as an object of public torture? It is not to the point that experts concede that there can be no torture; for, so long as the class referred to think there is, that thought is what will, in all likelihood, modify future legislation in conformity with it."

It is in fear that the "women part of the family" will be afraid of it, and manifest repugnance to it, that Mr. Batchelor wishes electricity to be no longer used in connection with capital punishment. But why does this estimable gentlemen conjure up Bogie? That people may develop a repugnance and dread of electricity is only a possibility. It is a fact that this repugnance exists towards death by the guillotine, the axe, and the rope, yet these things are in daily use. Machines on the guillotine principle are used in metal working factories; the delicate note paper upon which my lady pens her *billets doux* has been cut by such machines, and they are used in her kitchen for manipulating the household bread. The "basket" is a necessary adjunct of the guillotine, yet my lady is never seen shopping without it, or its equivalent, and it is to be found in her boudoir containing dainty embroidery and similar trifles. The axe she sees in use in her garden without a qualm, and she is familiar with ropes, and even makes use of the running noose in her fancy work without a shiver of horror. It is simple, farfetched foolishness, to suppose that because electricity may assist in doing a man to death with the minimum amount of pain, that the ladies, and therefore the whole community, will decline to have electricity in their houses, when the axe, the rope, the basket, and even the guillotine-machine conjure up no horrifying thoughts when they are in daily use. This might be pursued *ad absurdum*, if we have not, indeed, done so already; but enough has been said to answer Mr. Batchelor's timorous suggestions, and we can only wonder that the *Electrical Age* should subscribe to them, as it appears to do in its editorial note on the subject.

THE OSCILLATIONS OF HERTZ.

THERE is a paper in a recent number of the *Comptes Rendus* (May 9th) by Mons. H. Ponicaré in which the propagation of the oscillations of Hertz are mathematically considered. Since the rapidity with which these oscillations die away is now known, the theory given by Hertz for this propagation along a wire does not appear to be sufficient and Mons. Ponicaré believes that it may be replaced by another.

The substance may be gathered from the following considerations:—

Let a fine rectilineal wire be taken as the axis of z; this wire will have a free end which may be taken as the origin of co-ordinates. Let it be supposed that at this origin some cause produces a disturbance. How is this disturbance propagated along the wire and in the surrounding dielectric?

Let A be any point whatever on the wire, u its distance from the origin. M is a point in the dielectric, x, y, z, its co-ordinates, ρ its distance from the wire, r its distance from the point M, r_0 its distance from the origin, such that

$$\rho^2 = x^2 + y^2$$
$$r^2 = \rho^2 + (z - u)^2$$
$$r_0^2 = \rho^2 + z^2$$

Suppose that the disturbance is propagated along the wire with a speed constant and equal to the velocity of light. Choose the units in such a way that this speed may be equal to 1. Let $\mathrm{F}(u - t)$ be the current at the point A. Let Π be the function of Hertz, that is to say a function of ρ, z and t, such that the magnetic force and the two components of the electric force perpendicular and parallel to the wire may be respectively

$$\frac{d^2\Pi}{d\rho\, dt}, \quad -\frac{d^2\Pi}{d\rho\, dz},$$
$$\frac{d^2\Pi}{d\rho^2} + \frac{1}{\rho}\frac{d\Pi}{d\rho}$$

We shall then have, applying a formula which has been developed in a previous communication by Mons. Ponicaré,

$$\Pi = \int_0^\infty \frac{\mathrm{F}(u - t + r)\, du}{r}$$

Put $u - t + r = a$

whence

$$\int_{r_0 - t}^\infty \frac{\mathrm{F}(a)\, da}{a + t - z}$$

$$\therefore \frac{d\Pi}{d\rho} = -\frac{\mathrm{F}(r_0 - t)}{r_0 - z}\frac{\rho}{r_0}$$

If M be very near the wire, r_0 will differ very little from z, hence we shall obtain approximately

$$\frac{d\Pi}{d\rho} = -2\frac{F(z-t)}{\rho}$$

Hence it follows that in the immediate neighbourhood of the wire the magnetic force and the component of the electric force perpendicular to the wire varies almost inversely with ρ. Similarly for the component parallel to the wire. If the point, M, is very near the wire the expression reduces approximately to

$$\frac{2}{z}[F(z-t) - F'(z-t)].$$

The exact equation of the lines of electric force is

$$F(r_0 - t)\left(1 + \frac{z}{r_0}\right) = \text{constant}.$$

These lines cut the wire normally, which justifies the assumption that the speed of propagation in the wire is equal to the velocity of light.

But Mons. Ponicarè does not take account of the fact observed by Blondlot that the disturbances dies away in being propagated; hence it is necessary to push the approximation farther, and, perhaps, also to take account of the diameter of the wire.

ELECTRIC LIGHTING AT TOPEKA, KANSAS.

A PAPER of considerable interest was recently read before the American Society of Civil Engineers by Mr. Lewis Kingman, giving particulars of the cost of working the arc light plant owned by the city authorities of Topeka, and in the course of this paper and the discussion which followed it, the advisability of municipal authorities undertaking the lighting of their towns was debated, the general opinion of the meeting on this somewhat vexed question being, apparently, in favour of their doing so. Although other matters are brought into the discussion, the real point at issue between the advocates of municipal lighting and those against it must be that of the relative cost to the ratepayers, as it can hardly be argued that a municipal authority is not free to undertake the lighting of the streets for which it is responsible, if by so doing it can save the ratepayers' money; unless, of course, it has by agreement assigned such rights to some other party.

Since the whole question is thus practically reduced to one of relative cost, it might be thought that there would be no great difficulty in settling it; but, as a matter of fact, the position of affairs is as follows:—The advocates of municipal lighting cite figures to show that, whereas when the city owns its own plant the cost per lamp per night is generally under 20 cents, when the lighting is done by a company the cost, with few exceptions, lies between 30 and 50 cents; whilst their opponents answer by denying the correctness of the figures given by municipal authorities, and quote cases in which they show that many important items of cost are left out of account by those who prepare the municipal figures. The most striking case is, perhaps, that of the lighting of Chicago, where the cost of an arc lamp per night was stated to be 10 cents by one party and 37½ cents by the other, whilst in a communication from Chief Superintendent Barrett, of Chicago, which is printed with the discussion, the following statement is made:—"Our lights are now costing about $100 per annum, not including interest, taxes, or depreciation. Our lamps are 2,000 candle-power (nominal), 601 being high tension and 392 low tension, operated from four power stations, with the circuits all underground. The lamps are lighted from dusk till daylight every night in the year, the average being 10 hours and 45 minutes each night." From the above it will be seen that the cost per lamp per night works out at nearly 27½ cents, and when to this is added interest, taxes, and depreciation, it will probably be increased to 35 cents at least.

With a view to placing on record accurate figures of the cost to the city of Topeka, Mr. Kingman publishes a tabulated statement taken from the reports of the superintendents, which, for a period of rather over two years, gives for each month the number of nights and hours the plant was in operation, the weight and cost of the coal used per month, and also per horse-power per hour indicated by the engines, the costs of oil and waste, of carbons, of repairs, and of superintendence and labour, together with the expenses for insurance and telephone, and interest at the rate of 6 per cent. on the cost of the plant; the result being that, for 672 nights with an average of 8·08 hours of running per night, the cost per lamp per night works out at about 30 cents. It will be observed that here, also, nothing is charged for taxes, and that although the cost of repairs to plant is charged, no allowance is made for depreciation.

The plant consists of three boilers, three Ball engines of 75 H.P. each, six Jenney arc dynamos, and 184 arc lamps arranged on six circuits having a line mileage of 24·72 miles, with 33·5 miles of wire suspended on 30-foot cedar poles; the cost, inclusive of station buildings, being $55,448. Tests were made which showed that the lamps required, on an average, 440 watts each, and that the engines indicated 235 H.P., the efficiency of the whole plant, or ratio of E.H.P. at the lamps to I.H.P. of the engines, being therefore about 46½ per cent., which was referred to in the discussion as a very good result. The coal used was the best bituminous lump coal, costing on the average $2.67 per ton; but notwithstanding this, and the fact that an arc lighting plant of this character is worked under very favourable conditions, that is, that when in operation it is always working at full load, the consumption of coal per I.H.P. per hour amounted to 6·33 lbs., which, with the efficiency stated above, is equivalent to about 18·25 lbs. per Board of Trade unit delivered at the lamps. As might be expected from these figures, the proportion that this cost of coal bears to the total cost is high, being 26·04 per cent., the other items being superintendence and labour 36·24 per cent., oil and waste 1·36 per cent., carbons 5·79 per cent., repairs 8·66 per cent., insurance, &c., 2·45 per cent., and interest on cost of plant 19·46 per cent.

Another point to which reference was made in the paper was the uneven lighting due to the distance between the arc lamps, and Mr. Kingman, whilst condemning the ordinary incandescent lamps of low candle-power as unsuitable for street lighting, was of opinion that lamps of a candle-power intermediate between them and the arc lamps were required to obtain an even distribution of the light. This view was accepted by other speakers, but it was argued that although the lighting would be better, the enormous difference in cost put the use of incandescent lamps out of the question. If, however, the figures as to efficiency and coal consumption given above can be taken as representing fair average results with arc lighting plants in America, it would seem that lighting by means of high candle-power incandescent lamps, using machinery such as may be found in our London central stations, could compete fairly well as regards cost of maintenance; as with such machinery working at its full load the coal consumption per unit might be reduced to about one-third of that given above, which would allow of three 200 candle-power lamps being used in place of one arc lamp; a change which, although not giving such a brilliant light at points near the lamps, would give a much better distribution of light in the majority of our streets. This is a question which some of the supply companies might, we believe, study with advantage; as, even supposing it to be necessary to use an alternating current transformer system on account of length of circuit, the efficiency would still compare very favourably with that of arc lighting, since the transformers would always work at their best load, and there would be a considerable saving in the labour bill for cleaning and trimming the arc lamps, and a further saving of the cost of carbons and of repairs to be set against the cost of renewing the incandescent lamps. Although it is difficult to get accurate figures of the cost of lighting in factories, we have reason to believe that where high candle-power incandescent lamps have been substituted for arc lamps, the actual cost of the incandescent lighting, setting aside the further advantage of greater steadiness of the light and immunity from breakdowns, has been found to compare favourably with that of the arc lamps; and although a supply company, operating a larger number of lamps and having greater facilities for maintaining the plant in good order, is, of course, working under conditions more favourable to the economic use of arc lamps, we believe that

the advantages of having only to employ one type of machine, and of being able to supply public and private lamps from the same mains, should make it well worth their while to take the matter into serious consideration.

THE CUTTRISS CARBON RELAY FOR SUBMARINE CABLES.*

BY CHARLES CUTTRISS.

UNTIL within a comparatively recent period, telegraphy was the most important branch of electrical engineering, but of late years developments in electric lighting, power and traction have been so marvellous, and we have become so accustomed to calculate and think of volts and ampères by the thousands and tens of thousands, that the mind has to exert itself somewhat to realise that instruments using only the hundred-thousandth of an ampère for a maximum current, and a millionth of an ampère for a minimum current, are in daily use, and that by means of them we annihilate time, and link together the Old and New Worlds. Nevertheless, this is a fact, and by means of these minute currents, communication at the rate of 25 words per minute is steadily maintained over the Atlantic cables for hours at a time. That this may be done, it has become necessary to abandon to a great extent the old system of manual transmission, and to adopt an automatic mechanical transmitter, so that we can now insure the same perfection as regards the shape of the signals and the required spaces, at the end of a 12 or 24 hours' run, as we had at the start.

A few years ago the public were content to send a message to London and get an answer within an hour; now they can get it in a minute or two; but still the cry is for quicker communication. As the adoption of the automatic system of transmission has increased the carrying capacity and speed of long cables to the utmost, we can only hope for still more rapid communication between terminal stations, by saving the time now lost in the necessary re-transmission of messages at intermediate stations. This, of course, can be done by interposing a relay which shall automatically repeat into the second cable the signals which come over the first one. As all signals over a submarine cable of any length are of an undulatory character, it becomes necessary that this relay should repeat these undulations into a local circuit as faithfully as a telephonic receiver reproduces the undulations of the diaphragm of its transmitter.

After many failures to attain this end during the last 10 years, the instrument shown diagrammatically in the accompanying engraving has been invented by the writer. By its means the connecting in series of a number of short cables of about 800 to 1,000 miles in length or the connecting of a short cable to a long one is perfectly feasible. Up to the present time a relay, known as the Allen and Brown, has been practically the only one that would work Morse over cables 500 miles long, and with cables of this length the utmost delicacy of adjustment was necessary to obtain satisfactory signals.

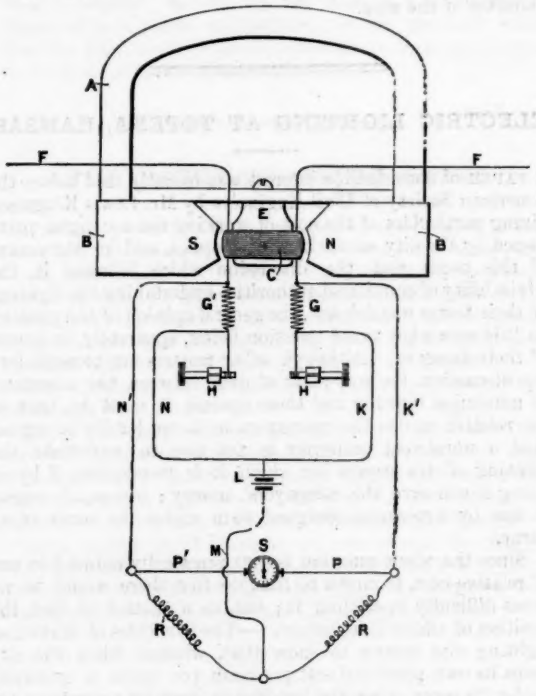
Heretofore there has been no instrument which would repeat recorder signals into a local circuit, thereby making it possible to have several offices in a city working directly on to a through cable after the manner in which Morse instruments at various offices work on to one trunk line. In the spring of 1889 I first obtained reliable recorder signals in a local circuit by means of a repeating relay in circuit with the Commercial Cable Company's Canso-New York cable, the copper resistance of which is 13,600 ohms, with an electrostatic capacity of 233 microfarads and a length of 855 knots; the cable is duplexed, and a battery power of 30 volts is used for signalling.

The relay was crude, and consisted of a coil of peculiar shape, which carried two small carbon discs, and which moved in a magnetic field; this coil was placed in the cable circuit. Opposite to the two discs were carbon points, which were connected in a local circuit to the receiving instrument, consisting of two ordinary 8-inch horseshoe magnets, between the poles of which a small coil carrying the syphon was pivoted, the syphon dragging over the surface of the paper.

When the operator at the distant station sent signals, to my surprise they were recorded on the receiving instrument perfect in shape and character, and subsequent measurements showed that the power in the local circuit was upwards of 50 times as great as the initial cable current. Since then I have experimented in every way to find the best form of contact points, but have finally rejected points of any shape as the adjustments had to be too delicate, and the points showed a great tendency to stick and burn.

I then turned my attention to making helices of carbon, and found that by substituting them for the adjustable points all the troubles incident to sticking and burning were eliminated, and that they gave a variable circuit that is entirely under the control of the movable coil. The relay now repeats most minutely all the undulations of the cable currents.

The strength of the currents in the local circuit can be augmented to such a degree, that the local instrument requires no delicate parts, and can be adjusted by the operator instead of requiring the services of a skilled mechanician.



THE CUTTRISS CARBON SUBMARINE CABLE RELAY.

As will be seen, N, S are the poles of a permanent magnet; E is an iron core situated between them, so as to concentrate the lines of magnetic force into two fields, in which a coil, C, is pivoted at the top and bottom. Thus far the instrument is a copy of the syphon recorder; but instead of using metal springs, weights, or analogous devices to bring the coil back to zero, after it has been deflected by a signal, I have substituted the carbon helices, G, G', connected to the coil by fibres or otherwise, and it will be readily seen that any deflection of the coil must open one spiral and close the other.

Normally, the circuits, M, R', R, K', N', G, G', N, K and L, are so balanced, that there is no difference of potential at the extremities of the wires, P and P', consequently the local instrument, S, is unaffected. Should, however, a signal be sent through the coil, C, it will tend to close one of the carbon spirals and open the other, thus throwing the local circuit out of balance and energising the local instrument, S, to a degree corresponding with the movements of the coil; the amount of the energy thus developed follows the laws of the Wheatstone bridge.

By varying the resistance in the local circuit and the strength of the battery, we can obtain any desired power in the local instrument, and, if necessary, a number of them

* The *Electrical Engineer*.]

can be placed in various offices in a city by means of the circuit, P, P'.

It was while experimenting with the instrument, and observing the perfect manner in which the weak cable signals were reproduced by these carbon helices, that I was led to try them as a telephonic transmitter, and was not surprised to find their action all that could be desired.

THE CURRENT THAT KILLS.

IV.—*(Concluded.)*

WE now come to the consideration of the position of the points of contact, and consequent distribution of the current in the body.

It is manifest that whatever function or functions of the current may be relied upon for the fatal effect, the current should be so directed, that its greatest energy may be expended upon the organ or organs most susceptible to such function or functions; in other words, that the particular organ or organs should be, as far as possible, in the line of greatest current density. What do we find to have been the case, however? Take the heart as an example. In six of the cases the current was passed along the body from head to lower spine or leg, and in the seventh from hand to hand. Now the heart being situated within the cavity of the chest, is included in one of the largest (generally the largest) cross sectional areas of the body. The transverse section of the chest is, say, four times that of the arm, and twice that of the leg, while the longitudinal section is still greater. As the whole space of the chest is occupied by organs varying little, if at all, in their electrical conductivity, it follows that there would be great diffusion of current therein, greater here, indeed, than in any other part of the body, except, perhaps, the abdomen. Consequently, by the method adopted, the heart was in the line of least current density instead of in that of the greatest.

Herein may perhaps be found some excuse for the large currents used; for supposing the heart to occupy one-fifth of the total transverse sectional area of the chest cavity, and that the current diffusion was equal throughout, then only one-fifth of the current employed touched the heart (less than ½ ampère in some of the cases), and the remaining energy was wasted.

Is it not also possible that this matter of current density may have had an important influence in the Kemmler case, wherein contact was made at crown of head and lower spine? The heart lies nearer the front than the back, and as the line of greatest density lay on this occasion along the spine and its surroundings, there was probably not a large amount of diffusion into the front of the body. Thus the heart could have only received a small part of the total current, and hence the delayed death in this case.

Much more might be urged on this point, but we think we have said enough to show that current density ought to have received more attention.

Now as to the brain contact. It has long been acknowledged by electro-therapists that currents passed longitudinally through the brain are far less unpleasant in their effects upon the patient than those passed transversely. (*See* Article I.) Yet we find the electrocutionists trusting to a longitudinal passage of current.

We cannot leave the consideration of the brain contact without expressing doubt on the advisability of using alternating current upon the head for the purpose aimed at. Over and over again authorities tell us that the brain is more affected by the passage of continuous current than by alternating current. To quote the words of Drs. Liebig and Rohé, "Confusion of thought, occipital headache and nausea or vomiting sometimes follow attempts at brain galvanisation. Very strong currents have caused fainting and convulsions" (note that the expression very strong is used in the medical sense, and probably does not mean more than 10 or 12 milliampères). Again, "*no vertigo is produced when the faradic* (alternating) *current is used.*" If, then, it was desired to produce fatal effect on the brain, it is hard to see the reason for employing an alternating current while there is good reason for the use of continuous current, especially if it had been used transversely.

In conclusion, we cannot help expressing surprise that after all the attention the subject has received in America from medical experts, both before and after the adoption of electrocution, such apparently haphazard methods should have been resorted to. The *rationale* of these proceedings seems just about as scientific as that of the man who went to the Falls of Niagara to drown a kitten:—"If there is not water enough to suffocate it, perhaps the pressure will knock the breath out of its body; or if there is not pressure enough, perhaps there will at least be enough water to suffocate it; anyhow, poor pussy is not likely to live after it." They turned on to the criminal an enormous amount of electrical energy:—"If the initial shock don't drive the breath out of the body, perhaps electrolysis may produce molecular disintegration; or if electrolysis does'nt succeed, perhaps something else will produce functional death. Anyway, the man is not likely to live after it."

We have endeavoured to show that if the electrocutionists trusted to initial shock, or to local death of some vital organ, or to electrolytic action, in neither case was the form of current used best suited to the purpose; and, further, what they did use was passed through the body in the manner least likely to prove effective. Consequently the total energy employed was far in excess of the amount needed.

In saying what we have done we do not wish it to be thought that we necessarily condemn electrocution as a means of inflicting the death penalty, or that we consider the *humane* condition has been neglected. We have simply pointed out the great want of scientific accuracy which marks the proceedings, and endeavoured to warn our readers that the current that kills may be, and most likely is (under favourable circumstances), a mere fraction of that used in these electrocutions.

THE "INSULATING SADDLE STAPLE."*

SINCE the introduction of electric lighting the wire staple has become an object of great consideration and solicitude. Prior to this time it was an insignificant but quite indispensable article, and probably would never have played an important part in the electrical field had electric lighting not appeared upon the scene.

The ordinary metal staple has been the cause of so much trouble on wires, that inventors have given their attention to the matter, with a view to devising some way to overcome these difficulties.

Metal staples are objectionable because they cut the insulation of wires in the operation of driving them; this, of course, results in leakage of current, either from one wire to the other or to the ground. Besides this leakage a weak spot is developed on the wires where the insulation is damaged. Moisture is enabled to penetrate, and eventually causes a corrosion of the copper wire. Frequently the conductor itself is broken by the pressure of the staple upon it, in the operation of driving the staple, and trouble of this sort causes considerable annoyance and delay, because it frequently escapes detection at the time.

The board of underwriters does not permit the use of metal staples for electric lighting and power work on account of the objections named.

The "Insulating Saddle Staple," a description and illustration of which are given herewith, was designed to over-

come the objections met with in the use of the ordinary metal staple, and from the fact that the board of underwriters approves of it, and requires its use in wiring buildings for electric light and power, is evidence that it meets all of the requirements of a perfect, safe, and reliable staple.

* *Electrical Age*, America.

By reference to the illustration it will be seen that the staple has a "saddle," which is made of vulcanised fibre, and firmly attached to the staple. The "saddle" is treated with a moisture-repelling compound, which also coats the metal in such a way as to prevent corrosion and the leakage which would ordinarily take place where the old form of metal staple is used. These staples do not abrade the insulation on the wires, drive equally well in hard and soft woods, and they are neater and stronger than cleats. They are valuable for electric light and power conductors, telephone, district messenger, burglar alarm, annunciator or telegraph wires, especially where wires run in moist places.

The Vulcanised Fibre Company, 14, Dey Street, New York City, has the exclusive agency for the sale of "Insulating Saddle Staples" throughout the world, and has perfected machinery whereby large quantities of these staples can be produced at greatly reduced cost.

TRANSFORMER TESTS.

REPORT OF TEST BY DR. HOPKINSON OF TWO TRANSFORMERS OF 6,500 WATTS EACH, MANUFACTURED BY THE WESTINGHOUSE ELECTRIC COMPANY.

BEFORE giving any of the results of the tests I have made with your transformers, it will be well to explain the methods of experiment adopted. The instantaneous value at any epoch in the period of the difference of potential between any two points of a circuit in which the potential difference is varied periodically, is made effective on the measuring instrument by means of a rotating contact maker attached to the shaft of the alternate current generator. This contact maker was constructed for the King's College laboratory by Messrs. Siemens Brothers; it makes contact once in each revolution for a period of about $\frac{1}{2}^{\circ}$, and breaks it for the rest of the revolution. It is entirely insulated, and so can be connected to any part of any circuit. The position of the contact can be varied and the variations be read off on a graduated circle of 13½ inches diameter divided into degrees, and by estimation the variation can be read to one-tenth of a degree. The two points between which it is desired to measure a potential difference are connected through the contact maker to a condenser and a quadrant electrometer, as shown in fig. 1, in which A and B are the

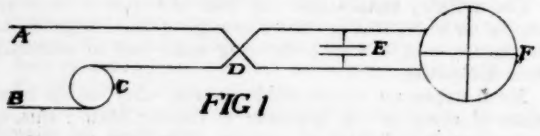


FIG 1

points, the potential difference of which, at a stated epoch, is to be measured; C, the revolving contact maker; D, the reversing switch of the electrometer; E, the condenser of which the capacity can be varied; F, the quadrant electrometer. It is evident that the quadrant electrometer will give a reading proportional to the potential difference of A and B when C makes contact. If there were no leakage, it would at once give this potential. It is to obviate the effect of leakage that the condenser is introduced, and the amount of the effect was determined by varying the condenser, thus:—When the condenser had capacity 1, 0·5 and 0·2 microfarads, the readings of the electrometer for a given potential difference of an alternating current at the position in the period of maximum electromotive force were 138, 136, and 132 respectively. The rate of loss of potential will be proportional to the reciprocal of the capacity, whence we at once infer that the true reading, if insulation were perfect, would be 139½, and hence the readings are always corrected by adding 1 per cent.

When the potential difference was too great for the electrometer, it was reduced in any desired ratio by two considerable resistances introduced between the points to be measured in the usual way, thus:—

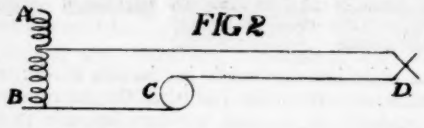


FIG 2

The potential difference may of course be measured in other ways. An ordinary voltmeter may be placed between A and B, in which case it must be standardised with the contact breaker in circuit, and it will depend for its constant on the duration of the contact which may vary; further, it gives not the difference of potential at any definite epoch, but the mean difference for the whole time of the contact, The condenser may be used, and its potential be measured by discharge through a galvanometer; this is open to the objection that if there be any leakage the result will depend on the time at which the contact is broken by the condenser key in relation to the time at which it was made by the revolving contact maker. Lastly, a Clark cell may be used by a method which Major Cardew pointed out to me, thus:—

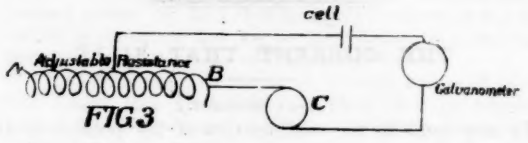


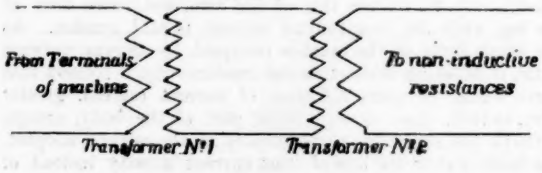
FIG 3

The resistances being adjusted till there is no deflection.

This is open to the same objection as the first, namely, that it gives the mean of the potential differences which occur during the contact. By making use of the first-mentioned method, we have the means of measuring accurately any potential difference at any epoch of the period, and of knowing the epoch.

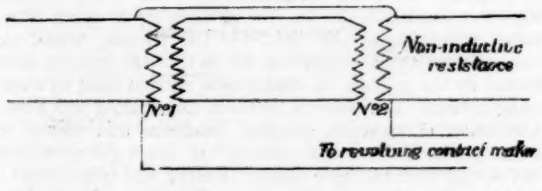
For these experiments two transformers intended to be identical were available, each transforming between 2,400 and 100 volts. It was most convenient, on account of the resistance available, to couple these transformers up from 100 to 2,400 in the first or No. 1 transformer, then down from 2,400 to 100 in the second or No. 2 transformer, and to take up the energy from the second in a non-inductive resistance. The arrangement is thus:—

FIG 4.



The obvious way of determining the efficiency of the combination would be to measure at various epochs of a half period the potential differences of the terminals of the machine and the current passing to the No. 1 transformer, in like manner at the same epochs to measure either the potential differences or the current passing to the non-inductive resistance, thence to deduce the power supplied to the first transformer and taken from the second. This would be open to certain objections. We are comparing two nearly equal magnitudes, and desire their ratio; the ratio will be afflicted with the full error arising from an error in the determination of either magnitude, and such errors may be material, as the observations are not simultaneous, and conditions may change between one series of observations and another. These objections are avoided by the method adopted. The current from No. 2 is observed at certain epochs, the difference of current between No. 2 and No. 1, and the difference of potential difference of No. 2 and No. 1 at the same epoch. These give the currents and potentials of No. 1 at the same epochs as the corresponding determinations of No. 2, and the difference will only be afflicted with the proportion of error of those differences. For example, suppose the efficiency of the combination were 90 per cent., and the possible error of determination of power 1 per cent., our result might be anything from 88 per cent. to 92 per cent., if made in the obvious way, but if made by differences the maximum loss would be 10·1 per cent., and the possible least determination of the efficiency would be 89·8 per cent. The method is essentially similar to the method I described,* and subsequently used for testing dynamos. The measurements are made as follows for difference of potential differences:—

FIG 5



For current difference, where G (fig. 6) is a known small non-inductive resistance. The two currents will, of course, slightly distu b each other, but this is readily allowed for in the calculations.

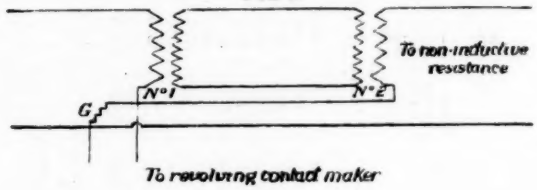
Another method would be to couple them thus (fig. 7) G 1 and G 2 being equal non-inductive resistances. This arrangement is quite free

* *Proceedings* of the Institution of Civil Engineers, Vol. lxxxiii., p. 235, and *Transactions* of the Royal Society, Part I., p. 347. (1886.)

from disturbance, but requires two resistances adjusted to exact equality. A single transformer can be tested in the same way, though, in this case, reliance must be placed upon resistances to reduce the current of the low potential coil, and to reduce the potential of the high potential coil in the ratio of the number of windings in the two coils.

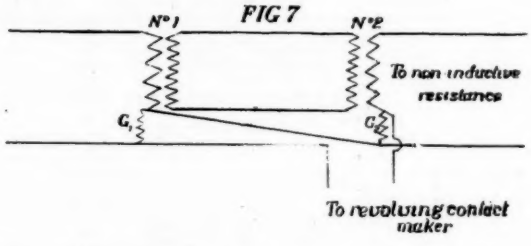
The current was throughout generated by a Siemens alternator, with 12 magnets, run at a speed between 830 and 840 revolutions per minute, which gives a frequency of 5,000 per minute, or 83 to 84 per second.

FIG 6



* The first experiment tried was with the two transformers coupled, but with No. 2 transformer on open circuit, or on nearly open circuit, for a high resistance, for purposes of measurement, was interposed between the terminals of the low resistance coil of No. 2 transformer. The actual results are given in Table I., and are expressed in Curves 1.

FIG 7

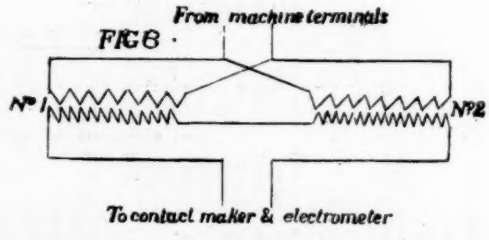


Tables II., III. and IV. gives the results for half power, nearly full power, and full power, and the sets of curves of corresponding numbers give the results of the tables. In these tables the first column gives the position of the contact brush in degrees, so that 60 on this scale corresponds with a complete cycle. Three degrees are thus $\frac{1}{83{\cdot}3 \times 20}$ of a second. The second column of No. I Table is the current in the thick coil of No. 1 transformer, as determined by the difference of potential at the two ends of a non-inductive resistance in which the current passes. The third column is the potential difference of No. 2 transformer, a direct determination. The fourth column is solely for the purpose of determining the square root of the mean of the squares of the third column. The fifth column is a direct determination of the difference of potential of No. 1 and 2, obtained in the manner explained with reference to fig. 5. The sixth column is the deduced potential difference of the terminals of the thick wire of No. 1 transformer, being the sum of the third and fifth column. The seventh column, like the fourth, is merely for the purpose of determining the square root of the mean of the squares of column six, whilst the eighth gives the rate at which power is given out by or received by the pair of transformers.

If the transformers had been exactly equal, the potentials for the two given by Table I. would have been equal, though they would have differed a little in phase, owing to the lines of magnetic induction which pass through the non-magnetic space between the two coils of the transformer.†

The difference shows that No. 1 transformer has a ratio of transformation slightly greater than No. 2. If we correct the potential of either No. 1 or No. 2, there still remains a difference between them, but this difference will be greatest about when the potentials are *nil*. This is due to the lost induction just referred to. In order to check the conclusion that the two transformers are not precisely equal, they were directly compared as follows:—

FIG 8



The transformers were coupled parallel as in fig. 8, and the difference of potential of the two high potential coils was measured, the value of its square root of mean square was 12·5 volts, the potential of the transformer being 2,400. This does not necessarily imply that the potentials of the two transformers differ by ½ per cent., it may be largely due to the difference of phase between the two.

The current supplied to the No. 1 transformer is to be accounted for by the currents necessary to magnetise the two transformers, and by the local currents in their cores. To ascertain the former, the curve of magnetisation of one of the transformers was determined by the ballistic galvanometer for nearly the same induction as in Table I. The changes of current supplied by a battery being made by a reversing switch or by suddenly introducing resistance into the primary circuit, and the consequent changes of induction being measured by the galvanometer. The tardiness of change of current in the transformer due to its self-induction was sufficiently reduced by using many cells and a considerable resistance. The results are shown in Curve 5 for a single transformer. In this curve, the abscissæ are the currents in the thin coil of the transformer, divided by 24, to reduce it to the same effect as it would have had if it had been in the thick coil. The ordinates are the inductions as measured by the kick on the galvanometer, but reduced to a scale to make them directly comparable with the volts when the transformer is used with an alternating current. These results are not given in absolute units. The procedure to determine points on the curve was, first, pass the maximum current corresponding to the point, C; next, suddenly diminish the current by inserting suitable resistance in the thin coil circuit, and observe the kick, the drop of ordinate from C to A corresponds to the kick, and the abscissa of A is the current after it has been reduced. Next reverse the current, and observe the kick; the kick corresponds to the further drop of ordinate from A to B. In this manner a series of points are determined on the curve. Curve 6 shows the relation between induction and magnetising current for the pair of transformers, as deduced from the experiments with alternating currents set forth in Table I. The ordinates in this curve are the areas of the curve of potential of Curve 1, for the ordinates of this latter curve are the rates at which the induction is changing, whilst the abscissæ are the currents in the thick wire at corresponding times. The points marked in Curve 7 give the remainder, after deducting the magnetising current as estimates in Curve 5 from the currents of Curve 6; that is to say, Curve 5 is corrected first for the small difference in maximum induction, then corresponding to any induction the current is taken from the curve; it is doubled, as there is only one transformer, and the result is deduced from the corresponding current of Curve 6. The differences are, the magnetising current equivalent and opposite in effect to the local currents in the cores. If the local currents were equivalent to a current in a single secondary circuit, the points of Curve 7 ought to have had the form of the full line of Curve 7 drawn through the points +, in which the abscissæ are proportional to the potential

TABLE I.

Lead of exploring brush on divided circle.	Current No. 1—Thick coil. Amperes.	Potential No. 2. Thick coil. Volts.	Square of volts √mean² = 101·1.	Potential No. 1.—Thick coil. P.D. differences, Section Nos. 1 and 2. Volts.	Volts.	Square of volts √mean² = 101·9.	Watts supplied to No. 1.
267	—2·2	+ 25·4	645	+ 0·9	+ 26·3	692	— 57·9
270	— 0·3	+ 70·2	4,928	+ 1·2	+ 71·4	5,098	— 21·4
273	+ 1·1	+ 95·3	9,082	+ 1·1	+ 96·4	9,292	+ 106·0
276	+ 2·1	+ 120·4	14,496	+ 1·1	+ 121·5	14,761	+ 255·1
279	+ 2·8	+ 147·7	21,816	+ 1·1	+ 148·8	22,140	+ 416·6
282	+ 3·2	+ 147·2	21,668	+ 0·9	+ 148·1	21,935	+ 473·9
285	+ 3·4	+ 119·8	14,351	+ 0·7	+ 120·5	14,520	+ 409·7
288	+ 3·5	+ 97·8	9,565	+ 0·6	+ 98·4	9,683	+ 344·4
291	+ 3·7	+ 71·3	5,084	+ 0·4	+ 71·7	5,140	+ 265·3
294	+ 3·5	+ 26·0	676	— 0·03	+ 25·97	674	+ 90·9
			102,311			103,935	2,282·6

difference and the ordinates to the induction. Returning to Table I. we find that the fall of potential difference on open circuit in the whole combination is 0·8 volts, and that the loss of power in magnetising the cores and in local currents is 228·26 watts, that is a loss for each transformer of 114·13 watts. The total loss of 228 watts may be divided into 126 watts, accounted for by hysteresis, and 102 watts due to local currents.

Referring now to Table III. and Curve 3 the earlier columns explain themselves, but a word is necessary about the last six

* So far as I know, the first discussion of endless magnetic circuit transformers, based on the actual properties of the material, is in a note by myself (*Pro. Roy. Soc.*, Vol. xlii., and *Electrician*, Vol. xviii., p. 421). Definite results were obtained by methods generally similar to those now used by Mr. Ryan (*Electrician*, January 10th and 17th, 1890). The theory of transformers is well set forth by Prof. Fleming (*Electrician*, April 22nd and 29th, 1892).

† Prof. Perry has already pointed out that the effect of such lost induction cannot be entirely neglected, even in endless circuit transformers.

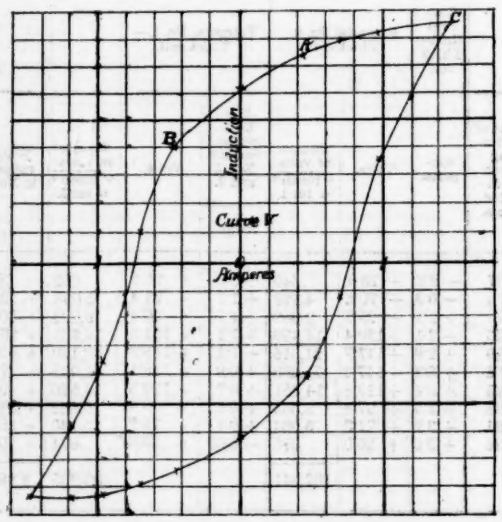
columns. The watts supplied to No. 1 are simply the products at each time of the volts at its terminals, and the ampères, passing through, similarly to the watts given out by No. 2. We see, firstly, that the efficiency of the whole combination with this load is 93·73 per cent., and hence the efficiency of one transformer, if the losses in the two are equal, may be taken as 96·9 per cent. The fall of potential in the whole combination is 6·1 volts, but the fall with no load is 0·8 volts, hence the variation due to the load with constant potential on the thin coil of No. 1 is 5·3 volts, or if the fall of potential in the two transformers were equal, which it is not, for a single transformer, 2·65 volts. Assuming that the transformers are equal, the power lost in resistance would be expected to be the mean of mean current × the difference of potential difference or 215·4 watts. It is, in fact, 150 watts, as given by multiplying the square of currents by resistances. But the transformers are not exactly equal, and there is the waste magnetic field, both of which will have a small effect on the distribution of loss between the two classes of loss, viz., that by hysteresis, and local currents, and that by resistance, but none upon the gross efficiency.

The other Tables, II. and IV., are arranged in exactly the same way as Table III., but the number of observations on Table IV. is insufficient to bring out all the peculiarities of the transformer.

It has already been stated that if the loss of potential due to load in the two transformers be equal, it will amount to 2·65 per cent. The following experiment was tried to ascertain if this loss was equal:—The transformers were coupled in series as before. The mean potential difference of the thick wire was measured by Thomson's multicellular, and of the thin wire by Thomson's electrostatic voltmeter; the mean of a considerable number of experiments is given in the following table, the load being the same as in Table III., and the results being corrected to the same potential of the thin wire.

	Full Load.		Open Circuit.	
Number.	Thomson multicellular.	Thomson electrostatic.	Thomson multicellular.	Thomson electrostatic.
1	2,380	99·8	2,380	97·0
2	2,380	94·2	2,380	96·2

This shows that of a total drop of 4·8 volts, 2·8 volts occurred in No. 1, and 2 volts in No. 2. There is no doubt of the fact that the drop is greater in No. 1 than in No. 2, which is connected with the waste field between the two coils. Of course these transformers are intended to work exactly as No. 2 is working, in which case the drop



from no load to nearly full load, as shown by this experiment, is 2·0 volts. The way in which this waste field causes inequality of drop of potential in the two transformers, coupled as in my experiments, is well worthy of careful consideration. The waste field is proportional to the current in the transformers, or better, to the mean of the two currents in ampère turns. The electromotive force due to this waste field will be proportional to the rate of change of the current. If the current were expressed by a simple harmonic curve, the electromotive force due to the waste field would also be a simple harmonic curve differing in phase by $\frac{\pi}{2}$. The curve of potentials is roughly in the same phase as the curve of current. Let A be the amplitude of potential difference of No. 2 transformer, B be the amplitude of difference of potential difference in No. 2, or the potential difference of the thin wire divided by 24. 2 b will be very nearly the amplitude of difference of potential difference between

TABLE II.

Lead of exploring brush on divided circle.	Current No. 2.—Thick coil.		Current No. 1.—Thick coil.				Potential No. 2.—Thick coil.		Potential difference.—No. 1.—Thick coil.					Mean of potentials in Nos. 1 & 2 thick coils	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance and probably waste field.			Loss by hysteresis and local currents.	Difference of potential due to waste field.
	Observed deflection.	Corrected deflection.	Ampères.	Current differences. Thick coils, Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Ampères.	Ampères.	Volts.	P.D. difference. Thick coils, Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Square of volts. $\sqrt{\text{mean}^2} = 10·4$				Resistance.	Losses unaccounted for—probably waste field.		
267	2·5	2·5	+ 0·6	189·5	189	+ 3·7	— 2·9	— 2·3	+ 5·6	315	308	+ 18·2	566	+ 14·7	— 55	+ 3	0·02	— 14·62	— 42·6	+ 18·2
270	65	65	+ + 16·0	77	77	+ + 1·5	— — 1·2	+ 14·8	+ + 51·9	278	273	+ + 16·1	4,624	+ + 6·0	+ 1,066	+ 530	8·7	+ 239·2	— 72·0	+ + 15·5
273	108·5	108·5	+ + 26·7	28	28	— 0·6	+ 0·4	+ 27·1	+ + 83·6	196·5	195	+ + 11·5	9,044	+ + 8·9·3	+ 2,577	+ 2,232	26·6	+ 282·7	— 35·7	+ + 10·5
276	145	145	+ + 35·6	99	99	— 1·9	+ + 1·5	+ 37·1	+ + 110·3	199	197·2	+ + 11·6	14,860	+ + 116·1	+ + 4,523	+ 3,927	48·5	+ 372·5	+ + 17·4·1	+ + 10·3
279	186	186	+ + 45·7	152·5	152·5	— 3·0	+ + 2·4	+ 48·1	+ + 141·1	203	201·2	+ + 11·9	23,408	+ + 147·1	+ + 7,359	+ 6,448	80·9	+ 477·2	+ 353·0	+ + 10·2
282	205	203·2	+ + 49·9	186	186	— 3·7	+ + 2·9	+ 52·8	+ + 153·6	61	61	+ 3·6	24,710	+ + 155·4	+ + 8,300	+ 7,655	96·8	+ 87·9	+ 450·6	+ + 1·7
285	184	184	+ + 45·2	203	201·2	— 4·0	+ + 3·1	+ 48·3	+ + 138·5	73	73	— 4·3	18,009	+ + 136·3	+ + 6,482	+ 6,260	80·3	— 281·3	+ 422·5	6·0
288	154	154	+ + 37·8	220	218	— 4·3	+ + 3·4	+ 41·2	+ + 114·9	75	75	— — 4·4	12,210	+ + 112·7	+ + 4,552	+ 4,343	57·5	— 231·3	+ 383·2	— — 5·9
291	123	123	+ + 30·2	238·5	235·5	— 4·6	+ + 3·6	+ 33·8	+ + 32·0	90·6	126·5	— — 7·5	6,904	+ + 83·1	+ + 2,808	+ 2,736	37·7	— 277·7	+ 312·8	— — 8·7
294	67·7	67·7	+ + 16·6	237	234	— 4·6	+ + 3·6	+ 20·2	+ + 47·7	253	248·5	— — 14·7	1,089	+ + 33·0	+ + 666	+ 792	12·5	— 283·0	+ + 14·5·1	— — 15·4
													115,424		38,218	35,236	449·5	371·6	2,162·4	
															92·2 %					
															298·2			298·3		

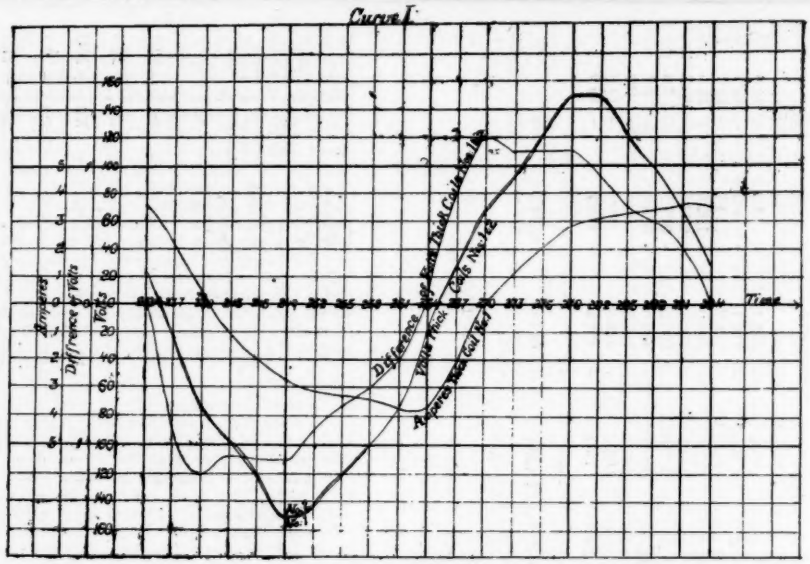
TABLE III.

Leads of exploring brush on divided circles.	Current No. 2. Thick coil. Amperes.	Current No. 1. Thick coil. Current difference. Secondaries Nos. 1 & 2. Ampères.	Current No. 1. Thick coil. Ampères.	Mean of currents in Nos. 1 and 2, thick coils.	Potential No. 2.—Thick coil. Volts.	Potential No. 2.—Thick coil. Square volts. $\sqrt{\text{mean}^2} = 98{\cdot}2$.	Potential differences, No. 1.—Thick coil. P.D. difference, thick coils Nos. 1 & 2. Volts.	Potential differences, No. 1.—Thick coil. Volts.	Potential differences, No. 1.—Thick coil. Square volts. $\sqrt{\text{mean}^2} = 104{\cdot}3$.	Mean of potentials in Nos. 1 & 2, thick coils.	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance and probably waste field. Resistance.	Loss by resistance and probably waste field. Losses unaccounted for—probably waste field.	Loss by hysteresis and local currents.	Difference of potential due to waste field.
267	− 15·0	− 3·1	− 18·1	− 16·5	− 20·6	424	+ 31·2	+ 10·6	112	− 5·0	− 192	+ 309	10·4	− 525·1	+ 15·5	+ 31·8
270	+ 15·0	− 1·6	+ 13·4	+ 14·2	+ 26·5	702	+ 29·7	+ 56·2	3,305	+ 41·3	+ 753	+ 397	7·6	+ 414·1	− 66·1	+ 29·2
273	+ 38·5	− 0·2	+ 38·3	+ 38·4	+ 63·0	3,969	+ 22·7	+ 85·7	7,345	+ 74·3	+ 3,282	+ 2,425	55·9	+ 815·7	− 14·9	+ 21·2
276	+ 57·1	+ 1·0	+ 58·1	+ 57·6	+ 91·8	8,427	+ 21·7	+ 113·5	12,880	+ 102·6	+ 6,595	+ 5,242	125·7	+ 1,124·3	+ 102·6	+ 19·5
279	+ 75·2	+ 1·9	+ 77·1	+ 76·1	+ 120·2	14,440	+ 22·2	+ 142·4	20,280	+ 131·3	+ 10,980	+ 9,038	219·4	+ 1,470·1	+ 249·5	+ 19·3
282	+ 88·8	+ 2·5	+ 91·3	+ 90·0	+ 141·6	20,059	+ 11·0	+ 152·6	23,285	+ 147·1	+ 13,930	+ 12,575	307·0	+ 683·0	+ 367·7	+ 7·6
285	+ 86·9	+ 2·8	+ 89·7	+ 88·3	+ 138·1	19,070	− 2·3	+ 135·8	18,440	+ 136·9	+ 12,180	+ 12,000	295·4	− 498·5	+ 383·3	− 5·7
288	+ 77·5	+ 3·1	+ 80·6	+ 79·0	+ 122·4	14,980	− 6·2	+ 116·2	13,502	+ 119·3	+ 9,365	+ 9,486	236·4	− 726·2	+ 369·8	− 9·2
291	+ 64·6	+ 3·4	+ 68·0	+ 66·3	+ 101·0	10,200	− 11·8	+ 89·2	7,957	+ 95·1	+ 6,066	+ 6,524	166·5	− 948·8	+ 323·3	− 14·3
294	+ 42·9	+ 3·5	+ 46·4	+ 44·6	+ 65·5	4,290	− 24·2	+ 41·3	1,705	+ 53·4	+ 1,916	+ 2,810	75·4	− 1,154·6	+ 186·9	− 25·9
						96,552			108,811		64,875	60,806	1,499·7	654·0	1,917·6	
											93·73 %					
											406·9			407·1		

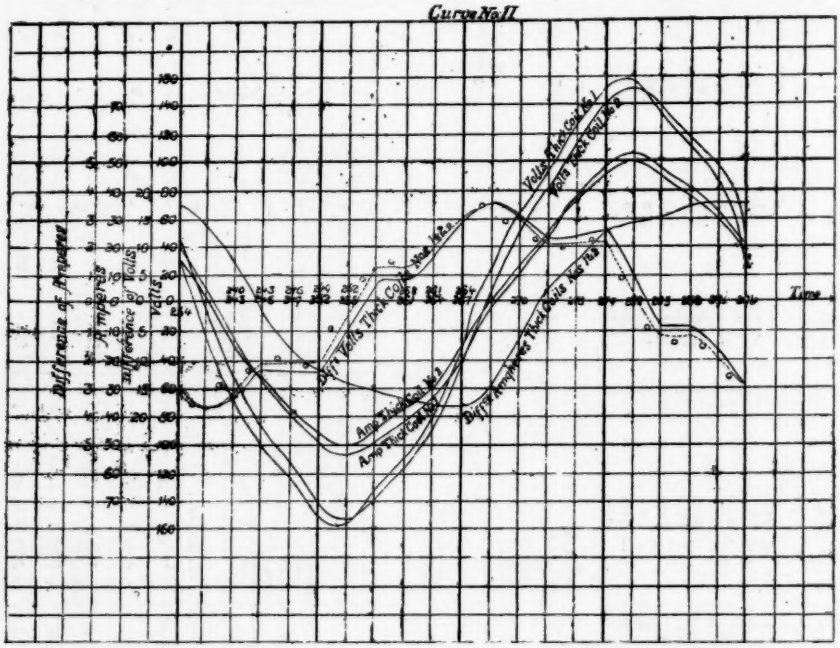
TABLE IV.

Leads of exploring brush on divided circle.	Current No. 2.—Thick coil. Observed deflection.	Current No. 2.—Thick coil. Corrected deflection.	Current No. 2.—Thick coil. Ampères.	Current No. 1.—Thick coil. Current differences.—Thick coils Nos. 1 and 2. Observed deflection.	Current differences.—Thick coils Nos. 1 and 2. Corrected deflection.	Current differences.—Thick coils Nos. 1 and 2. Volts.	Current differences.—Thick coils Nos. 1 and 2. Ampères.	Current No. 1.—Thick coil. Ampères.	Mean of currents in Nos. 1 & 2 thick coils.	Potential No. 2.—Thick coil. Volts.	Potential No. 2.—Thick coil. Square of volts. $\sqrt{\text{mean}^2} = 90{\cdot}9$.	Potential No. 1.—Thick coil. P. D. difference.—Thick coils Nos. 1 and 2. Observed deflection.	Potential No. 1.—Thick coil. P. D. difference.—Thick coils Nos. 1 and 2. Corrected deflection.	Potential No. 1.—Thick coil. P. D. difference.—Thick coils Nos. 1 and 2. Volts.	Potential No. 1.—Thick coil. Volts.	Potential No. 1.—Thick coil. Square of volts. $\sqrt{\text{mean}^2} = 98{\cdot}4$.	Mean of potential in Nos. 1 & 2 thick coil.	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance and probably waste field. Resistance.	Loss by resistance and probably waste field. Unaccounted for—probably waste field.	Loss by hysteresis and local currents.	Difference of potential due to waste field.
270	59	59	+ 14·3	107	107	+ 2·1	− 1·7	+ 12·6	+ 13·4	+ 21·3	454	355	345	+ 33·9	+ 55·2	3,047	38·3	695	304	6·8	+ 447·5	− 65·1	+ 33·4
276	256	252	+ 61·0	57	57	− 1·1	+ 0·9	+ 61·9	+ 61·4	+ 80·7	6,512	256	252	+ 24·8	+ 105·5	11,130	93·1	6,530	4,923	142·8	+ 1,380·2	+ 83·8	+ 22·5
282	427	410	+ 99·3	147	147	− 2·9	+ 2·3	+ 101·6	+ 100·4	+ 130·2	16,950	142	142	+ 14·0	+ 144·2	20,790	137·2	14,650	12,928	382·0	+ 1,023·5	+ 315·5	+ 10·2
288	381	369	+ 89·3	188	187	− 3·7	+ 2·9	+ 92·2	+ 90·8	+ 116·1	13,480	59	59	− 5·8	+ 110·3	12,165	113·2	10,170	10,367	312·3	− 839·0	+ 328·3	− 9·2
294	207	205	+ 49·6	211	209	− 4·1	+ 3·2	+ 52·8	+ 51·2	+ 62·4	3,893	266	262	− 25·8	+ 36·6	1,340	49·5	1,933	3,095	99·3	− 1,420·3	+ 158·4	− 27·7
											41,289					48,472		33,978	31,617	943·2	591·9	820·9	
																		93·05 %					
																		472·2			471·2		

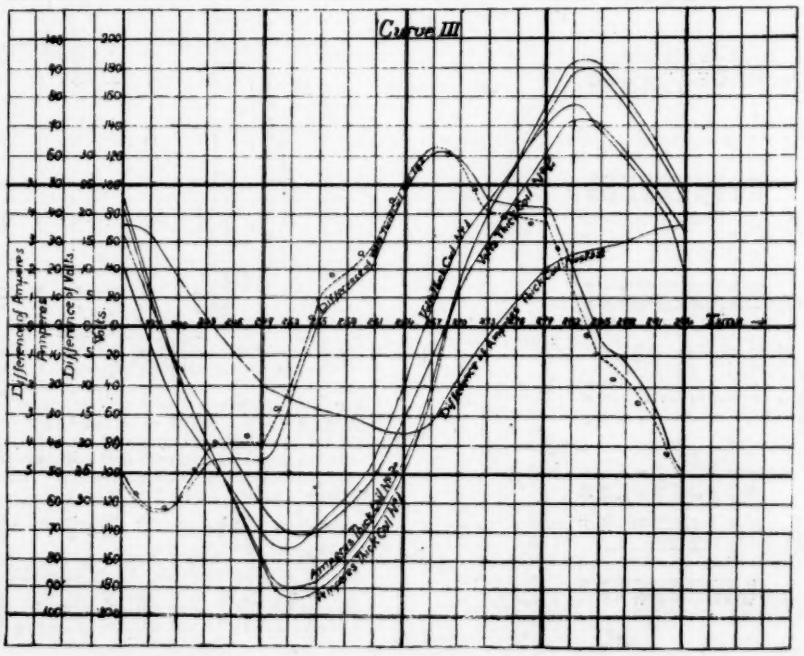
Curve I.



Curve No II


Difference of Amperes
Difference of Volts
Amperes
Volts
Time
Volts Thick Coil No 1 & 2
Volts Fine Coil No 1 & 2
Diff. Volts Thick Coil No 1 & 2
Diff. Amperes Thick Coils No 1 & 2
Amp Thick Coil No 1
Amp Thick Coil No 2

Curve III


Difference of Amperes
Difference of Volts
Amperes
Volts
Time
Diff. Fine Coil No 1 & 2
Volts Fine Coil No 1 & 2
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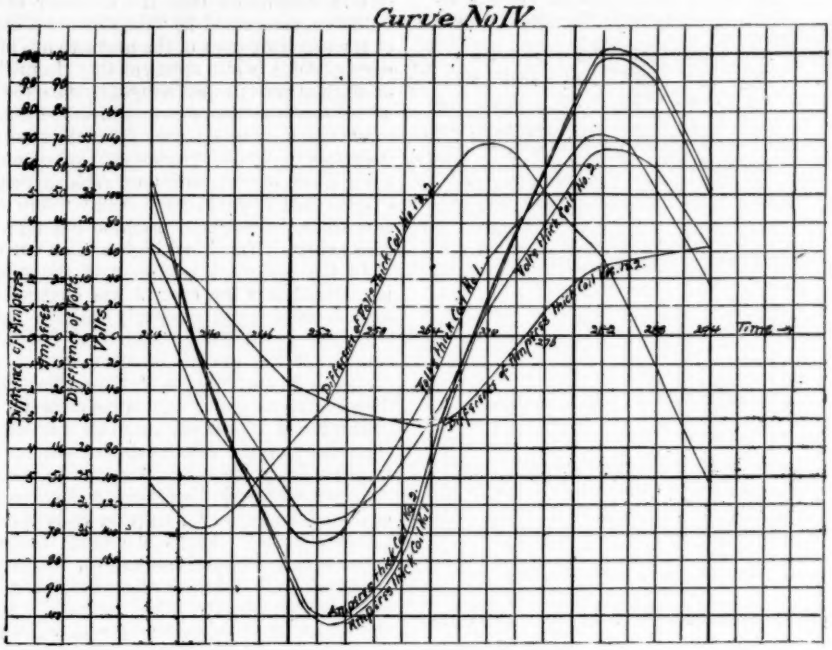
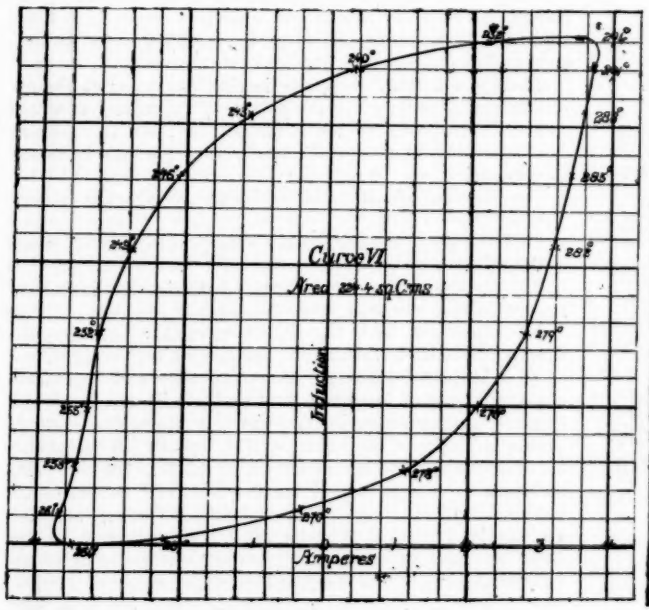
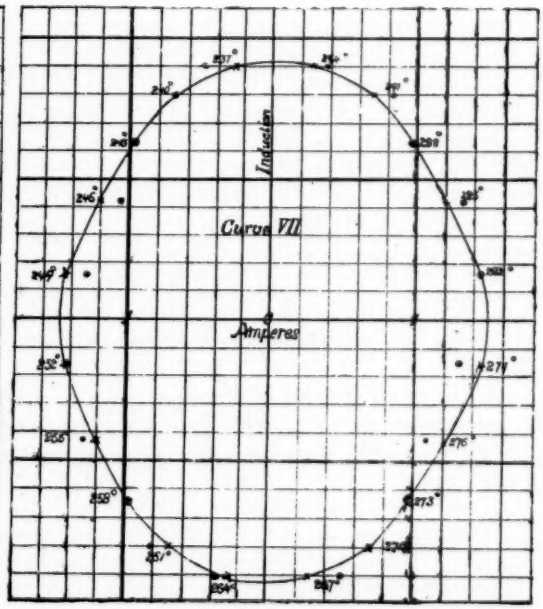
Amperes Fine Coil No 1
Amperes Thick Coil No 1







the thick wires of Nos. 1 and 2. The ratios of potentials in No. 1 and No. 2 will then be

$$\frac{\sqrt{a^2 + 4b^2}}{\sqrt{a^2 + b^2}} \text{ and } \sqrt{\frac{a^2 + b^2}{a}} \text{ or } 1 + \frac{3b^2}{2a^2} \text{ and } 1 + \frac{b^2}{2a^2}$$

or the drop in the first from this cause is three times as great as in the second transformer. We shall return to the waste field immediately. Putting aside harmonic curves, and returning to the facts as they are, the following Table V. gives first, half the difference of potential difference taken from Table III., that is, at each instant the drop of potential in No. 2, secondly, the volts of the thin wire of No. 2, reduced for number of convolutions; this is, of course, the mean of potential difference between 1 and 2; lastly, the squares of these volts. From this we see a mean square 100·8, showing the drop in No. 2 to be 2·6 volts, out of a total drop of 6·1, and the remainder 3·5, the drop in No. 1. Diminishing these results by 0·4, the half of 0·8, the fall observed with no load, the actual losses from no load to nearly full load will be 2·2 and 3·1.

Turn now to the last column of Table III. This gives the difference of potential differences corrected for the loss of volts by resistance. It is shown on the dotted Curve 3; this curve presents one or two peculiar features. It should be possible to infer the form of this curve from the curve of current. The rates at which the mean current is changing are as follows:—

TABLE V.

Half difference of potential difference.	Volts of high potential coil divided by 24.	Squares of volts.
15·6	−5·0	25·0
14·8	41·3	1,706·0
11·3	74·3	5,520·0
10·8	102·6	10,530·0
11·1	131·3	17,240·0
5·5	147·1	21,640·0
−1·1	137·0	18,770·0
−3·1	119·3	14,230·0
−5·9	95·1	9,040·0
−12·1	53·4	2,850·0

Square root of mean square = 100·8.

268½	271½	274½	277½	280½	283½	286½	289½	292½
30·7	24·2	19·2	18·5	13·9	1·7	−9·3	−12·7	−21·7	−28·1

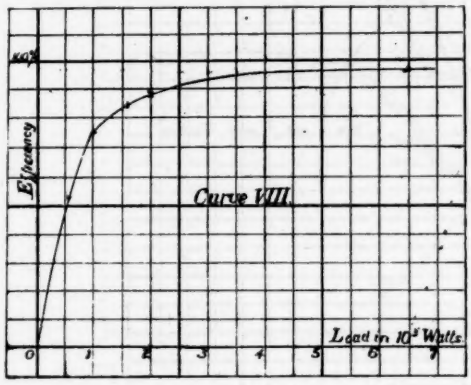
which happens to come to a scale which can be at once plotted. The points marked are the points of the curve corresponding with the

above rates. The agreement of the points with the curve is remarkably close. This exhibits very completely the effect of waste magnetic field in this transformer.

For half-power, as taken from Table II., the rates are as follows:—

268½	271½	274½	277½	280½	283½	286½	289½	292½	295½
14·6	11·5	9·4	10·6	4·4	—4·6	—7·2	—7·5	—13·6	—17·6

and in the same way, in Curve 2, the dotted curve represents the difference of electromotive force corrected for resistance, and the points correspond with the above rates.



Curve 8 gives the efficiencies in the terms of the load. This curve is the hyperbole:—

$$\text{Efficiency} = 100.\ \frac{x - (A + Bx + Cx^2)}{x}$$

Where A = 228 the loss by hysteresis.
B = ·005 and mainly depends upon the waste field.
C = ·0000035 and is mainly the loss by resistance.
x = load in watts.

To sum up, I find that the efficiency of the transformer at full load would be 96·9 per cent.; at half-load, 96 per cent.; and at quarter-load, 84·7 per cent. The magnetising current of the transformer amounts to 114 watts, or 1·75 per cent. The drop of potential from no load to full load is between 2 per cent. and 2·2 per cent.

In conclusion, I wish to express my thanks to Mr. Wilson, of King's College. This gentleman carried out the experiments under my direction, and made nearly all the numerical calculations, and drew most of the curves for me.

Dated this 31st day of May, 1892.

(Signed) J. HOPKINSON.

EARLY INSTANCES OF INDUCTION COILS, CONDENSERS AND SECONDARY BATTERIES IN A DYNAMO MACHINE CIRCUIT.

BY A. M. TANNER.

IT appears that Prof. Nollet, as early as the year 1851, had in view placing inductional transformers, condensers and secondary batteries in the circuit of a magneto-electric machine. This is evidenced by a French patent granted to Nollet on July 15th, 1851, No. 11,649. In this patent induction coils of a special construction, which cannot be positively determined by reason of the absence of drawings, were placed in the circuit of a magneto-electric machine. It is evident from the following translation of the description that the primaries of the induction coils were in series in the main circuit, as in the well known Jablochkoff system of 1876. Whether a house to house distribution of electric currents by induction coils was contemplated is, however, not to be gathered from the description, which is as follows, viz:—"I thus obtain a very strong current in the lower coil by means of this double induction, and the primary current, far from being weakened, is found to be increased by the reaction of the electro-magnet in such a manner that we can also cause it to pass through a numerous series of induction coils before closing the circuit of the primary current. It is evident that these different induced currents can produce similar phenomena to those produced by the primary current itself."

It is evident from the rather prolix and sometimes uncertain description that the diameter of the wires of the induction coils could be "the same or a little less than that of the armature coils of the magneto machine," and from the description it is also apparent that the quality of the primary or original current was changed by the induction coil. Whether a "step up" or a "step down" transformation was accomplished, must naturally be inferred from the size of the wires of the induction coils. With induction coils described in one place as being made of flat bands or ribbons instead of wires, it is evident that it would have been a "step down" transformation since the magneto machine having thin wire armature coils evidently furnished high tension currents.

In the historical treatment of the subject, however, it is immaterial how the current was changed or transformed, so long as the description clearly indicates that a system of distribution by induction coils was contemplated. It is of course not the writer's intention to set up this patent of Nollet as an anticipation of the modern practical systems of distribution by inductional transformers; attention is merely drawn to the Nollet patent so that it can properly figure in the history of the distribution of electric currents by transformers.

It is a noticeable fact that Nollet considered condensers as the equivalents of induction coils and the description of the patent clearly shows the broad features of the systems subsequently proposed by Stanley, Westinghouse, and others, to have been foreshadowed by Nollet in the following language, viz.: "The idea then came to me of placing in the middle of this condenser a second condenser of similar construction which then became charged with a suitable quantity of electricity, and this condenser by influence transmitted its electricity to a second condenser of the same kind, therefore considerably increasing the strength of the electric current."

There is a certain vagueness in the description of the use of condensers as found in the patent specification, for which reason it is probably not sufficient to meet the modern systems of distributing and transforming currents by means of condensers.

The 8th and 9th claims of the Nollet patent are as follows, viz.:—

8. The system of condensers for magneto-electric currents as described.

9. The application of secondary batteries for increasing the strength of currents, whether direct or induced.

In connection with the use of secondary batteries, the description is silent as to the construction and arrangement of such batteries, but it is evident that they were considered the equivalents of induction coils and condensers, for transforming magneto-electric currents. It will strike many as rather a curious fact that Nollet speaks of secondary batteries (piles secondaires) known in the year 1851, as being sufficient for the purpose of transforming or "increasing the strength" of currents from a magneto-electric machine. Ordinarily, Planté, in the year 1860, is considered as having been the first to construct secondary batteries adapted for industrial use. From the published experiments of Poggendorff, De la Rive, and Sinsteden, made about the time when Nollet procured his patent, it appears that secondary batteries were even at that period quite well known, and Sinsteden went so far as to propose the use of lead electrodes in secondary batteries. Planté, however, was the first to make a secondary battery adapted for industrial use, and as is well known, he only obtained satisfactory results by the selection of spiral lead plates, and a systematic way of "forming" the electrodes. It remains to be seen whether the brief description in the Nollet patent of secondary batteries in a magneto-machine circuit has any important bearing upon the well-known Lane-Fox patent. The writer is not aware that the experiments of Planté and Niaudet with a secondary battery in a dynamo machine circuit made by them in the year 1873, and published in the *Comptes Rendus* of the French Academy of Sciences, Vol. lxxvi., p. 1,259, were considered in the Lane-Fox suit. It is, therefore, well to make such description generally known. Translated into English it is substantially as follows, viz.:—When a secondary cell with lead electrodes is charged by a Gramme magneto-electric machine, we observed a phenomena which is a curious example of the transformation of mechanical force into electricity and of electricity into mechanical work. Gramme's machine, as is known, possesses the property of furnishing induced currents

in the same direction, and a secondary battery is charged by this machine in the same manner as by the action of a voltaic battery, so that at the end of some minutes effects can be given by the accumulated chemical action of the battery of greater strength than by the machine itself. This can be easily determined whether by the incandescence of a platinum wire or by any other physical action. After this follows the description of the "curious phenomena" referred to by Planté and Niaudet, viz., that when the dynamo is stopped the battery "works back" into the same and converts it into an electric motor.

THE TRAMWAYS INSTITUTE.

THE annual meeting of the Tramways Institute of Great Britain and Ireland took place at the Guildhall Tavern, City, on June 28th. The proceedings were opened by the president, Mr. W. Carruthers Wain, who was re-elected president of the Institute. Other general business having been disposed of, the following papers were down for consideration: "Permanent Way Construction, especially as regards wear and tear and depreciation," by Mr. T. Arnull, C.E., assistant surveyor of Birmingham; "On the further development of the Connelly motor in England and America," by Messrs. Sharpe and Weyman; "Electric Traction—the City and South London Electric Railway," by Mr. G. Annesley Grindle, C.E.; "Accumulator Traction," by Mr. L. Epstein; and "Accumulator Traction, a few months' working at Croydon (Jarman's system)," by Mr. A. J. Jarman. The annual dinner took place in the evening at the Crystal Palace, where an inspection of the Electrical Exhibition was previously made. On the morning of Wednesday a visit to view the line and works of the City and South London (Electric) Railway, by invitation of Messrs. Mather and Platt, was paid, and in the afternoon tests with the Connelly motor were made at the London, Deptford, and Greenwich Tramways Company's depôt, at Lower Road, Deptford.

Previous to the reading of the papers, Mr. Carruthers Wain referred to the progress which had been made in electric locomotion during the past decade, and particularly in the United States. In England, however, very little had been done, and for that matter many obstacles were placed in the way of general tramway work. He suggested that local authorities should acquire the tramways, and that they should be leased to the companies to work. Concerning the Tramways Act of 1870, the efforts put forth by the Institute to get a committee appointed by the Government to investigate the working of that Act had been unsuccessful, but he hoped that next year, with a new parliament, something would be done.

The paper by Mr. Arnull was read and discussed, after which Mr. Sharpe dealt with the Connelly motor. Next came under consideration the paper by Mr. G. A. Grindle.

In the discussion on this paper Mr. Scott-Russell criticised the arrangement of a separate locomotive as compared with the motors being carried under the cars themselves. He was of opinion that by the latter method much dead weight would be avoided.

Mr. A. J. JARMAN considered that the risk of a breakdown would be minimised by the motors being coupled in parallel. With the series arrangement if a wire got cut the motor would be stopped, but with the motors wound in parallel there would always be one leg of the field magnet to work.

Mr. RECKENZAUN said that the City and South London line was the first of its kind, and it was wonderful that few accidents had occurred. He confirmed the opinion of the previous speaker concerning the placing of the motors in parallel.

Mr. HOLROYD SMITH who supported the two previous speakers in the matter of parallel working, would have been glad to hear what was the mechanical efficiency of the electrical power put in the line. He considered the method adopted of a separate locomotive was the only one which conformed to the structure of the line.

Dr. E. HOPKINSON pointed out that by the adoption of a separate locomotive the weight of the whole train of 50 tons had only been increased by 4 per cent., and that that was hardly worth taking into consideration.

In the discussion on Mr. Epstein's paper, Mr. H. BUTLER remarked that the Electrical Power Storage Company would undertake the maintenance of their batteries at a certain rate. He doubted whether the efficiency of 78 per cent. stated by Mr. Epstein could be maintained.

Mr. RECKENZAUN believed the Epstein battery to be good, but it had not been practically tested in actual tramway work. The figures in the paper were very interesting, but they were only on paper. He considered the average efficiency of the storage battery to be not more than 33 per cent.

Mr. EPSTEIN briefly replied, after which the paper on "Accumulator Traction" was read by Mr. Jarman.

NOTES.

Erratum.—Dr. Gore, in writing to us regarding the abstract of his research on "A Relation of Electromotive Force to Equivalent Volume and Molecular Velocity," which we have been printing in our columns lately, says:—"I have at present only noticed the following misprints in it. On page 723, 12th line from top, 'ten' should be '*two*,' and on page 786, half way down, 1st line of paragraph 2, the words 'to be' should be '*been*.'"

Electric Mining Plant.—We publish elsewhere an extract from a paper read by Mr. D. Selby Bigge before the North of England Institute of Mining and Mechanical Engineers. It gives a clear description of a plant recently supplied to Lord Durham's colliery at Bunker's Hill, and is worthy of attention by those who are interested in the transmission of power by electricity.

Correction.—With reference to a Note last week on page 803, headed "Personal," we have been informed, on the best authority, that the cable therein mentioned was laid by Mr. Theophilus Smith, and the land line erected by Mr. James Hall, of Henley's Telegraph Works Company.

Putney and Hammersmith Electric Lighting.—At a meeting of the Hammersmith Vestry last week, it was decided that the £300 deposited with the vestry by the Putney and Hammersmith Electric Lighting Company be returned, the company having abandoned their lighting scheme.

Electric Lighting at Exeter.—On the ground that the electric light would cost too much, the Exeter City Council have once more, after a great deal of talk, decided to continue with gas lighting.

Electric Traction at Bradford.—We are informed that the experiments undertaken by Messrs. Easton & Anderson, in conjunction with Mr. M. Holroyd Smith, on behalf of the Bradford Corporation, to demonstrate the efficiency of electric energy in propelling tramcars up steep hills, have been brought to a successful conclusion, and arrangements are now being made for the construction and equipment of two miles of line where the average rise in the total length is 1 in 24, the road in many places being as steep as 1 in 13·3. The Corporation has consented to allow the temporary overhead conductors used for the demonstration to remain in position for another fortnight, in order that gentlemen from other towns, interested in tramways, may witness the running of the car. Should any of our readers desire to personally inspect the tramcar and its working, they may, on application to the London office of Messrs. Easton & Anderson, Limited, 3, Whitehall Place, be furnished with the necessary permits for so doing.

New Telegraph Line in South America.—The *Financial News* states that Mr. Augustus de Missoli has applied for permission to erect a telegraph line on the Tesla system between Buenos Ayres and Rosario. The company, which has already the necessary capital, is to go under the style of Electrofonia Franco-Argentina. The Department-General of Postal and Telegraphic Service has reported favourably on the proposal.

Want of Space.—Owing to this being Index number, we regret that we are reluctantly compelled to omit from our columns several important articles.

Bournemouth Electric Lighting.—Notice was recently given to the Bournemouth Town Council that the Bournemouth and District Electric Supply Company intended laying underground mains along certain roads. Consent of the council was given, subject to the company depositing plans drawn up to a proper scale, and subject to the approval of the surveyor.

Electric Lighting Charges.—A meeting of the secretaries of some of the principal London clubs was held at White's Club last Monday, to discuss the question of the heavy charges which are being made by the electric lighting companies for the supply of the electric current. A deputation from the meeting was appointed to wait upon the directors of the companies supplying these clubs to request that a considerable reduction should be made in the charges, which it was agreed unanimously had been most onerous. We may add that we have just received notice from the Westminster Electric Supply Corporation that they reduced the standard price of current supplied in their district to 7d. per unit, from this date (July 1st).

Accidental Death.—Last Tuesday afternoon, at Guy's Hospital, an inquest was held by Mr. S. F. Langham on Alfred Moyses, aged 24, an electric light engine driver. William Charles Ullman, an engineer, deposed that he and the deceased were employed by the Brush Electric Light Company, Bankside, Southwark. On Wednesday afternoon witness had occasion to use sulphuric acid in the work, and left a bottle containing the poison on a switchboard. Shortly afterwards witness was informed that one of his men had fainted, and a boy said he thought the deceased had drunk some of the acid. Witness at once sent him off to the hospital, where he died on Saturday. The bottle, it appears, was labelled "British Wine," and there was no label to say that it contained poison. The jury returned a verdict of "Accidental death," and thought the Brush Company and their foreman were to blame for allowing sulphuric acid about the premises without its being labelled poison.

Multiphase Motors.—The alternating current high tension power transmission installation at the Telluride Mine, Colorado, described in a paper by Mr. Scott, read before the Chicago meeting of the American Institute of Electrical Engineers, is interesting for more reasons than one. It not only describes what appears to be a very successful practical power transmission, but it affords a clue to the real opinions of the Westinghouse Company's experts. Our readers will remember that the Westinghouse Company introduced the Tesla multiphase motors, and, as we have always pointed out, credit must be given to Mr. Tesla for having invented and developed in a practical way that method of working. The Westinghouse Company have made many of the Tesla motors, and must be supposed to know as much about the practical results of multiphase working as any of those engineers who have recently adopted the system, and yet we here find the Westinghouse Company bringing forward simple alternators and synchronising non-starting motors, *i.e.*, simple alternators worked as motors, as the most practical and successful mode of transmitting power by alternating currents. If this means anything at all, it means that, at any rate, in America the company associated with multiphase transmission has tried that method and found it wanting, and has preferred the simpler plan, in spite of the inability of simple alternator motors to start from rest. We are reminded in this connection of the experiments of Mr. Mordey, made some three years ago, and of his advocacy of simple alternators as motors. He then pointed out that such motors when once started possessed more advantages than any other motors whatever, direct or alternating; and it appears from the account of the Telluride plant that this is now the opinion of the most experienced American house, and that the starting is, after all, a very simple and easy matter. It will be noticed that for starting purposes a modified Tesla motor is used, and the inference is, of course, that such a motor, although useful for starting, was not good enough to be trusted with the real work.

The Electric Light in Japan.—The Kumamoto garrison at Nagasaki, Japan, is being fitted with an electric light installation, the necessary plant having been obtained from England.

The Strike of Telegraphists in Spain.—The strike of the telegraph operators throughout Spain was brought to a close on the 24th ult. (June), owing to the mediation of the Minister of the Colonies.

Electric Railway between Antwerp and Brussels.—A demand for a concession to construct an electrical railway between Antwerp and Brussels has just been made to the Belgian Government by Mr. P. Van den Kerkhoven, of Ghent. The average time occupied in making the journey by rail at present is one hour, but by the electric railway it is proposed to reduce this to 25 minutes.

Institution of Electrical Engineers' Conversazione.—We are asked to state that in consequence of the limited cloak-room accommodation at the Institute of Painters in Water Colours, it would be desirable if soft or opera hats (rather than ordinary tall hats) were worn by those attending the conversazione this evening.

Overhead Wires.—On Wednesday afternoon, Mr. Courtenay Boyle received at the Board of Trade offices, Whitehall Gardens, a deputation representing the Electrical Trades Section of the London Chamber of Commerce on the question of the London County Council Overhead Wires Bye-laws.

Government and the Telephone.—In the House of Commons on last Monday, the Lords' amendment on this Bill were considered. Sir J. Lubbock moved that the House disagree to the Lords' amendment taking away from the County Councils the control of overhead wires. He thought there was grave doubt as to the expediency of the Bill, and that this doubt had been strengthened by what had taken place in the House of Lords. The House divided—For the Lords' amendment, 65; against, 11; majority for, 54. The amendment was agreed to, as were the other Lords' amendments to the Bill.

Personal.—We hear that Major-General Webber has ceased to act as chief engineer of the City of London Electric Lighting Company.

Transformer Tests.—The report which Dr. Hopkinson has just made on some Westinghouse transformers seems to go more thoroughly into the whole question than anything hitherto published. Dr. Hopkinson also shows a form of testing which we believe is quite new, and which gives most accurate results.

Brechin Library Electric Lighting.—It has been decided by the Brechin Town Council to place wires in the Public Library buildings for the introduction of the electric light, at a cost not exceeding £30, so that the electric light can be introduced at a future time if considered advisable. The policy of this decision does not seem quite apparent, for wires do not improve in a building by lying idle.

NEW COMPANY REGISTERED.

Pacific and European Telegraph Company, Limited.—Capital £100,000, in £10 shares. Objects: To acquire, construct, and cause to be manufactured, wires and cables of all kinds for the purposes of telegraphs and telephones; and to enter into an agreement to be made between the Brazilian Submarine, the Western and Brazilian, and the West Coast of America Telegraph Companies, this company, and Sir John Pender, K.C.M.G., for the construction and maintenance of telegraphic communication between Buenos Ayres, in the Argentine Republic, and Valparaiso and Santiago, both in the Republic of Chili. Signatories (with one share each): Sir John Pender, K.C.M.G., 18, Arlington Street, S.W.; Sir James Anderson, 62, Queen's Gate, S.W.;

T. Fuller, 13, Chesterfield Street, W.; A. Wood, Abbey Wood, Belvedere, Kent; Lord R. H. Browne, Reigate, Surrey; R. Collett, 50, Old Broad Street, E.C.; R. M. Cunningham, 19, Great Winchester Street, E.C. Each of the first three companies referred to above shall be entitled to nominate one director to this company, for each clear number of 2,300 shares of the original capital registered in the name of the nominating company. The number of directors is not to be less than three, nor more than five. Qualification, £100 (which may be held as the nominee of any other company). Remuneration to be determined from time to time by the company. Registered on the 24th ult. by Bircham & Co., 50, Old Broad Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

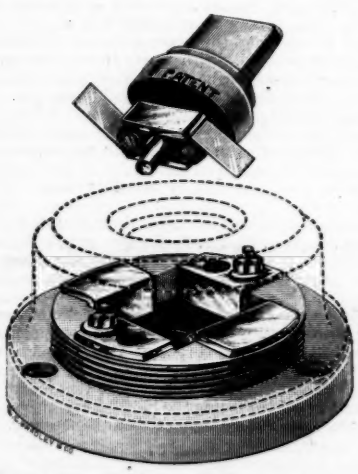
Bickle and Company, Limited (mechanical, marine and general engineers, electricians, electrical contractors and electrical engineers).—The registered office of this company is situated at the Great Western Docks, Plymouth. (Filed on the 13th ult.)

Electrical Standardising, Testing and Training Institution, Limited.—The annual return of this company, made up to December 31st, 1891, was filed on the 10th ult. The nominal capital is £10,000 divided into 1,900 ordinary and 100 founders' shares of £5 each. Seven shares have been taken up, but upon these no call has been made. Although the company was registered on December 31st, 1889, no registered office has as yet been filed.

Vaughan-Sherrin Electrical Engineering Company, Limited.—The following special resolution was passed at an extraordinary general meeting held on May 19th, 1892, at 37, Tabernacle Street, Finsbury, and was confirmed at a similar meeting held on June 10th, 1892, at the same place, viz.:—"That the company be wound up voluntarily under the provision of the Companies' Acts, 1862 to 1891."

BUSINESS NOTICES, &c.

Lundberg Switches.—We understand that the latest switch introduced by Mr. Lundberg is meeting with considerable favour. It is known as the "Unique," and its chief claim is its simplicity of construction and action. The key, base and cover are porcelain, the base having a square recess, in the centre of which is a small hole in which revolves the centre pin of the key. As will be seen by the figure, the key has attached to it two helical springs of metal ribbon wound on pins, the turning of the key to the right



having the effect of bringing the end of these springs either against the brass plates with which the wires are in contact, or to two similar brass plates which are insulated. As the key is turned, the springs are wound up on their respective pins and pass across the surface of the brass plates till they reach the edges, when, owing to the power absorbed by the springs coming into effect, they fly off from the plates independently of the motion of the key, producing make or break of the circuit in the most quick and satisfactory way.

The Electrical Coal-Cutting Contract Corporation, Limited.—The prospectus of this company, which was issued a few days ago, states the company's objects to be the adoption and carrying into effect of a certain agreement to be made between the Woodfield Syndicate, Limited, of the one part, and the company of the other part, for acquiring certain patents, and to carry on businesses of colliery proprietors, contractors, electricians, electrical engineers, producers and suppliers of electricity, &c. The patents to be purchased are chiefly those of Messrs. Atkinson and Goolden. The amount of share capital is £402,000 in 60,000 ordinary shares of £5 each, 20,000 deferred shares of £5 each, and 2,000 founders' shares of £1 each. No public issue is at present to be made, the amount to be allotted (10,000 ordinary shares) being so small. The directors of the company are Sir Archibald C. Campbell, W. T. Goolden, J. R. Knowles, Frank Stobart, J.P., Hon. G. W. Winn, and Lindsay Wood, J.P. We think that the formation of this corporation marks a new era in the coal industry. The practicability of the apparatus has been thoroughly tried, and the application of electricity to coal cutting will render the position of mine owners far more satisfactory with regard to their relations towards the miners, whose tendencies in the direction of strikes are, unfortunately, only too pronounced. The method of procedure adopted by the corporation, viz., contracting to cut coal with its own machinery and staff at a fixed sum per yard or ton cut, seems based on eminently sensible grounds, and it is difficult to see anything likely to militate against its chances of complete success.

Caution.—We feel it to be incumbent upon us to give warning to all manufacturers of electric light fittings and the electrical trades generally, against certain deliberate frauds that are at present being perpetrated by various individuals on the Continent, more particularly in Holland. Within the last few days our attention has been especially directed by an important London company to the matter. The company to which we refer recently received an order from a firm in that country, and unfortunately the goods ordered were despatched on what proved to be insufficient investigations. The firm ordering had somehow managed to obtain possession of the parcel, but were not to be found at the address given when payment was required. We may mention that the letter paper on which the goods were ordered was elaborately prepared with the object of deceiving the eye of manufacturers, and making them believe that the order emanated from a firm having a large establishment of offices, &c., and being of first-class repute, in a large way of business. More than one instance of these underhand tricks has occurred of late, and we have heard of several firms who have received enquiries from other firms in different continental towns who prove to belong to the same class of offenders. We would warn all those interested in such matters to in future insist more than ever upon the well-established rule of business, of taking none but first-class references when opening new accounts.

W. T. Glover & Company's New Catalogue.—A new catalogue has just been issued by Messrs. W. T. Glover & Co. This price list, which deals chiefly with electric light wires and cables, may be said to be one of the best of its kind ever published. No pains have been spared in the preparation of the most useful information which is given therein. Every care has been taken to have the particulars very concise, and so arranged, that, with very little trouble, customers can refer to any size or quality of cable they require; for instance, if a conductor is wanted formed of high conductivity, tinned copper wire of 1/22 S.W.G., of ·028 inches, or ·711 millimetres diameter of a certain resistance, of class No. 41 braided, in ordering it is only necessary to give the number of the standard gauge, with the number of class, from which Messrs. Glover will understand what is wanted; thus, number of gauge 1/22, number of class 41 = 12,241; or same gauge, No. 51 class = 12,251. This is somewhat similar to the telegraphic code system, and facilitates matters a great deal in ordering either by telegram or letter. We feel sure that the information cannot fail to be of great use to Messrs. Glover's numerous customers. The catalogue is most exquisitely printed on good paper in two colours, and we have great pleasure in recommending it to the notice of the trade.

Electric Light in the City.—Since we last reported in these columns as to the progress of the City private lighting, we notice that the following buildings are at present being fitted up for the electric light:—By Hayward Tyler & Co., new premises in Princes Street, E.C.; Strode & Co., new premises in Great Winchester Street, E.C.; Brush Electrical Engineering Company, in Messrs. Foster and Brathwaite's premises at 27, Austin Friars, E.C.; Laing, Wharton and Down at the Eastern Telegraph Company's Station in Old Broad Street, and at Nicholson & Co.'s premises at 4, Cheapside, and also in some buildings at 41, Eastcheap; Rashleigh Phipps & Dawson, at 22, Old Broad Street; J. & C. Christie in the premises of Thurston & Co., Bishopsgate Street Within, E.C.; Bourne & Grant, in the premises of Samuel, Son & Barter, 14, Eastcheap, E.C.; John Pound & Co., at Malvern House, Eastcheap, also at 12 and 13, Water Lane, E.C.; W. T. Goolden & Co., in the premises of Mr. Austin Withers, 22, Wallbrook, E.C. The Guildhall Library and Council Chamber are also to be fitted with the electric light.

Royal Agricultural Society.—Messrs. Priestman Brothers, Limited, of Hull and London, exhibited at the Warwick Show their patent oil engine of varying sizes from 1 to 18 H.P. The Priestman oil engine is now being largely adopted for electric lighting, and the firm showed one of their 5 H.P. engines of the new pattern, combining the latest improvements which experience has suggested, driving a dynamo supplied by Mr. F. M. Newton, of Taunton. The steadiness of the lights, which were run direct from

the dynamo, shows the great regularity with which this engine runs. For the first time in the history of oil engines, the Royal Agricultural Society adopted the Priestman oil engine for driving the dairy plant required in connection with the forthcoming dairy trials. This engine offers special advantages for this purpose, as it has the advantages of the gas engine without being dependent upon a supply of gas, which is rarely, if ever, available on dairy farms.

Maple & Company.—In a recent issue we referred to Messrs. Maple & Co.'s cabinet factory installation. We understand that this factory has now been lit up satisfactorily, and they are now commencing another installation in their new premises in Euston Road, which are now in course of erection. They have also nearly completed about 800 lights at the Euston Station Hotel, for the London and North Western Railway Company, on a three-wire system, which they will shortly connect to the St Pancras supply. Messrs. Maple are carrying out other numerous installations in London and the provinces. Their electrical department, which has been lately opened, is under the management of Mr. H. Gardner.

Another Electric Sailing Gig.—Mr. W. S. Sargeant has received an order for an electrical sailing gig from H. Smith, Esq., of Stile Hall, Chiswick, which is intended for the Norfolk Broads. She will be built of teak throughout, bright varnished, and is designed to give a mean speed through the water of 6½ to 7 miles an hour, and a run with one charge of six hours; the time occupied in charging the accumulators is about three hours. The motor for this small boat will be specially designed by Mr. Sargeant, and the accumulators will be supplied by the Electrical Power Storage Company, each cell containing 19 plates, T-type, 120 ampère-hours, sealed in teak boxes, and placed below the water line so as to give great stability for sailing, at the same time dispensing with ballast. She will be fitted with electric light, bells, and an electric port, starboard, and masthead light in one. She can be rowed, sailed, or electrically propelled at pleasure. Several similar gigs are now in course of construction, each accommodating six persons comfortably.

Tenders Wanted—Manchester.—The Art Gallery Committee are inviting suggestions and tenders from electrical engineers as to the best method of illuminating the entrance hall at the Art Gallery, Mosley Street; also for the lighting of the two new galleries with incandescent lamps similar to the system now in use at the present galleries. The various lights in entrance hall and two new galleries to be supplied from the present dynamos. For further particulars, apply at the City Surveyor's Office, Town Hall, Manchester. Tenders to be delivered at above office by July 7th, and endorsed "Tender for electric lighting at the Art Gallery," and addressed to the City Surveyor.

Tenders Wanted—Carshalton.—Tenders are being invited by the Carshalton Local Board for the lighting of their district with gas, oil, or other illuminant, at per lamp, exclusive of the cost of columns, frames and lanterns, for 12 months, from July 31st. There seems to be an opportunity here for electric lighting to be introduced. Tenders marked "Public lighting," and addressed to the chairman of the Board, must be deposited at the Board offices, High Street, at or before 12 noon on July 6th.

Tenders Wanted—Spain.—Tenders are being invited by the civil authorities of Mahon, Spain, until the 24th inst., for the electric lighting of the town during a period of 30 years.

Roper's Electrical Engineering Company.—An elaborate system of electric lighting has been installed in the Alhambra Theatre, Hull, by Roper's Electrical Engineering Company, of Bradford and Hull. The installation was in every respect a perfect and emphatic success, says the *Critic*. The number of lights in the entrances, pay boxes and office of the theatre is 188. The hall itself is illuminated by 24 ceiling and 23 balcony lights, and the lounge and bars by 56 lights. On the stage there are 66 lamps for the footlights, battens and dressing rooms. The total number of lights in all parts of the building is 357.

B. Verity & Sons.—The installation of the electric light at the Quinta at Shrewsbury was completed last month, the work being satisfactorily carried out by Messrs. B. Verity & Sons. The number of lamps fixed is 134, and they are all from 8 to 16 candle-power. The dynamo is of the Elwell-Parker type, worked by a Marshall's engine and boiler. Cables have been laid to supply light in the house, the conservatory, offices, and stables.

J. & G. Odhams.—This firm, whose address is 206 and 207, Upper Thames Street, have now issued the fourth edition of their illustrated catalogue of batteries, indicators, fire alarms, magneto-machines, electric bells and other electric lighting apparatus. The list consists principally of illustrations, but there is also a great deal of information given which should be useful to users of Messrs. Odhams's manufactures.

The Weymersch Electric Battery.—The sole manufacture of the Weymersch patent electric battery has now been taken over by Messrs. Sharp & Kent, of Victoria Street. A good feature in Messrs. Sharp & Kent's new departure is the announcement by the firm of an all-round reduction in the prices of the batteries.

J. G. Statter & Company.—We hear that Messrs. Statter & Co. have lately secured contracts for two electrical cranes for the Southampton Harbour Board, and for three 23-unit dynamos for Lord Rothschild's installation at Tring Park.

Julius Sax.—The internal telephone exchange system at the Imperial Institute, which provides for communication with 40 stations in various parts of the buildings, has been fitted up by Mr. Julius Sax.

Campbell Gas Engine.—A new price list of these engines is just issued, in which a large number of testimonials are included. Users of the engines appear to be unanimous in acknowledging the merits of the engine, especially the simplicity of its construction and its steadiness and regularity in working.

William Johnson & Company.—This firm have fitted up an installation of the electric light at the Wingfield Corn Mills of Messrs. C. Bower & Sons, Sheffield. The Elwell-Parker No. 3 type is the dynamo used.

J. Walsh Walsh.—We have received from Mr. Walsh a copy of his illustrated sheet and price list of new shades for electric light. The sheet contains a large number of different designs of shades, and is beautifully illustrated in a variety of colours.

Planet Electrical Engineering Company.—At the Rose Show held at the Mansion House on Friday last, the Planet Electrical Engineering Company arranged some pretty effects with incandescent lamps suspended amongst foliage and flowers.

Direct Spanish Telegraph Company.—The Spanish Inland Telegraph system, which was stopped on June 20th, was on Monday last stated to be in order.

CITY NOTES.

West Coast of America Telegraph Company, Limited.

THE fifteenth ordinary general meeting of this company was held on Monday last at Winchester House. Mr. Henry Roberts presided.

The notice convening the meeting was read, also the minutes of the previous meeting.

The CHAIRMAN, in moving the adoption of the report and accounts, said he would take the opportunity of referring to the loss they had sustained by the death of their late chairman, Mr. Marshall. Referring to the accounts and the report, the gross earnings, although showing a very large decrease as compared with the previous year might be regarded as satisfactory when all circumstances were taken into consideration. The year under review was ushered in with a revolution in Chili which was not terminated until the end of August. The cables of the company connecting the principal ports of Chili were interfered with by both parties to the revolution. The Mollendo-Arica and the Arica-Iquique sections were closed to public traffic by order of the Congressionalists from August 10th to 24th, and the stations at Santiago, Valparaiso, and Serena were closed to the public from January 20th to March 19th and from April 1st to September 1st by order of the Balmaceda Government. They paid the company some compensation for stopping its business until March 18th. With regard to the cutting of their cables, they had preferred a claim for the expenses incurred in effecting the repairs, and the matter was now under the consideration of the Government of Chili. All the expense of these repairs had been charged to the revenue account of last year. The negotiations with the Brazilian Submarine and the Western and Brazilian Telegraph Companies, conducted under the presidency of Sir John Pender, had been brought to a satisfactory termination, resulting in the formation of a new company, the share capital of which, £100,000, would be held by the Brazilian Telegraph Companies and this company. The new land line was already in course of construction. In addition to the share capital, one-quarter of which would be held by this company, there would be an issue of £100,000 of debentures, to which the shareholders of this company would have an opportunity of subscribing. Their competitor, the American Company, having acquired since January 1st last the existing land line between Valparaiso and Buenos Ayres, had so adjusted the tariffs as to exclude this company from participating in any European traffic at its principal stations, and this state of things would continue until the new line was completed. With regard to their earnings during the present year it had been thought desirable, owing to the competition, not to publish or issue in any form the monthly receipts. It was with much satisfaction that he announced that Mr. J. Denison Pender had allowed himself to be nominated at that meeting for election to a seat at the board. He then formally moved that the report and accounts for the year ending December 31st, 1891, be received and adopted.

The resolution was seconded by Mr. FREDERICK WALTERS, and carried unanimously.

Mr. J. Denison Pender was elected a director of the company.

The retiring directors, Messrs. H. Roberts and F. Walters, were re-elected, and Mr. Clark was elected auditor to the company, in place of Mr. Weise, who was unable to continue owing to ill-health, at a remuneration of 25 guineas.

The next resolution was one altering the articles of association. It was agreed "That the regulations of the company contained in the articles of association be altered in the following manner, viz., by inserting in Article 11, at the end of the third line thereof, the words 'or making purchases in,' and inserting in the fourth line thereof, after the word 'upon,' the words 'or in.'"

A vote of thanks to the chairman closed the meeting.

The West African Telegraph Company, Limited.

THE directors' report for the twelve months ended December 31st, 1891, states that the company's revenue for that period amounted to £60,214 5s. 11d., against which £20,883 8s. 5d., is charged for ordinary expenses, £2,213 8s. 3d. for expenditure relating to repairs of cables, &c., and £755 19s. 8d. for income tax, leaving a balance of

£36,361 9s. 7d. From this amount is deducted £23,722 8s. 4d. (being for interest on debentures £13,555 15s., and for sinking fund £10,166 13s. 4d.), leaving a balance of £12,639 1s. 3d., out of which the directors have placed £3,395 9s. 3d. to the general reserve fund. The shareholders have received for the six months ended June 30th, 1891, an interim dividend amounting to 3s. per share, and the directors now recommend a final dividend of 5s. per share, making together 4 per cent., free of income tax, for the year ended December 31st, 1891, which, with the appropriation to the general reserve fund of £3,395 9s. 3d., will absorb the balance standing to the credit of the revenue account. A considerable portion of the company's income is derived from the guarantee of traffic by the Portuguese Government. The revenue has been seriously affected by the depreciation of Portuguese currency, a loss of over £6,800 having been made during the year on remittances between Portugal and England. The board, are, however, endeavouring to have this question settled on a more satisfactory basis. During the 12 months under review, the cables of the company have continued in good working order. On February last, however, the cable between San-Thomé and Loanda was interrupted, but was promptly repaired by one of the Eastern Company's cable ships, the cost of which will appear in next year's accounts. The Bolamo-Bissao cable was broken on April 21st last, but as the interruption of this section did not seriously affect this company's traffic, the directors deemed it expedient to delay the repair until the arrival of the Eastern Company's cable ship, *John Pender*, en route for the Cape. The cable is now restored. A new station house has been erected at San-Thomé, and also a commodious and well ventilated building at Grand Bassam; these buildings will greatly add to the comfort and health of our staff there. The directors who retire by rotation are Sir John Pender, K.C.M.G., and Robert Kaye Gray, Esq., who, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also offer themseves for re-election.

The Chili Telephone Company, Limited.

THE directors in their report to March 31st, 1892, state they regret that the business of the company during the past year has been less profitable than that of the two previous years. This unfavourable result is due solely to the political and other abnormal calamities which befell the Chilian nation, and affected adversely the affairs of the company. The civil war in Chili is happily at an end, and the industrial, as well as the political position of the country, is steadily resuming a more settled and prosperous character. Whilst the affairs of the company for the past year have suffered from the misfortunes of Chili, there is every indication that they will share largely in the return of the national prosperity. The income from subscriptions and other sources, which in 1890—1 was $387,110, has fallen for the year 1891—2 to $378,830, showing a deficiency of $8,280, which appears very small, when it is remembered that the system of the company was monopolised by the State, and its use by the public suspended for eight months; whilst the destruction of its poles and lines by the retiring troops of the late president, by extensive incendiary fires, and by a snowstorm, such as has not been known in Chili for a century, delayed the resumption of the ordinary business of the company. The lines have been gradually, steadily, and as promptly as possible, restored, and the subscribers re-connected with the exchanges; so that the number of subscribers now served is nearly, if not quite, equal to what it was before the civil war began. The public disasters before-mentioned have increased the cost of maintenance and operating from $102,234 for 1890—1 to $165,400 for 1891—2, = $63,166. The general expenses have increased from $92,826 to $105,780 = $12,954, in consequence of the larger number of dollars paid to employés on account of the greatly reduced value of the dollar. Under the above headings there has been a diminution of revenue of $8,280, with an increase of expenditure of $76,120, and, therefore, a less favourable result in Chili by $84,400. As the bulk of the increased expenditure has been caused by the revolution, a claim has been made against the Government, of which $115,000 remains unpaid. No part of this sum has been treated as an asset in the company's accounts; whatever may be hereafter received from the Chilian Government will be credited to future revenue. The deficiency of profit, shown in paragraphs 5 and 7 of this report, has been further increased by the reduction in the rate of exchange, caused by the unfavourable financial conditions prevailing in Chili, from an average of 24d. to the dollar, in 1890—1, to 19½d. in 1891—2; so that, while the profit has been reduced by $84,400, the result in London has been further lessened by the fall in the value of the dollar. The net result of the working in Chili, in sterling, was in 1890—1 £19,205, and in 1891—2 only £8,746, showing the heavy deficiency of £10,459. The expenses in London have been reduced by £254, and the value of the dollar on March 31st, 1892, was more than in March, 1891, by 1d., which improved the balance of revenue, so that, taking all the items touching the transactions out of Chili together, a benefit accrued of £2,837, leaving the net deficieney as compared with 1890—1 £7,622. The balance of profit in sterling for the year was £6,067, which, with the balance brought from last year, viz., £14,209, makes £20,276 available for division. As the profits have been used for capital purposes, they cannot be divided in cash, but the directors recommend that deferred warrants be issued for 10 per cent. on the share capital, and that these warrants—at the option of the holders thereof—be accepted by the company for ordinary shares, which will carry dividend from April 1st, 1892. It will be observed that the capital outlay for the past year was £18,720 14s. 7d. This is due to the construction of new trunk lines, to increased capacity in pole routes during re-construction, and to preparation for connecting additional subscribers with the exchanges, whilst at the same time adding to the efficiency of the telephonic plant throughout the company's entire system. It is anticipated, however, that such further outlay of capital as may be required will be mainly for the purpose of connecting new subscribers to the system, and thereby augmenting the revenue. The general manager, in Chili, has succeeded in securing contracts for 10 years with the Government, and, for a like period, with the municipalities of Santiago and Valparaiso, by which the company materially strengthens its position.

In accordance with the Articles of Assocation, Mr. Frank W. Jones retires from the board of directors, and being eligible, offers himself for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

Eastbourne Electric Lighting Company, Limited.

ON Monday, last week, the annual meeting of the Eastbourne Electric Lighting Company, Limited, was held at the Clifton Hotel, Alderman G. Boulton (Chairman) presiding.

The report showed that the 15 months from September 30th, 1890, when the provisional order took effect, and December 31st last, a gross profit of £1,950 0s. 8d. was earned by the company over and above its working expenses during that period.

The CHAIRMAN, in moving the adoption of the report, mentioned that the first electric lighting of the Parade took place on Monday, September 4th, 1882. Up to December 31st, in 1885, the managers had spent between £15,000 and £16,000 in hard cash in putting in plant, and they had produced what they considered to be one of the best stations in the country. They had taken no interest for the cash, but were content to take debentures. They advanced the money believing that some time or other they would be repaid, and he was happy to say that he thought they were now coming to that. Without the money the company could not possibly have got on. The Eastbourne station and system had been considered excellent and many deputations had visited the works, including those from Kensington, the Paddington Vestry, Dublin, Portsmouth, Chester, Bedford, and other places. He would mention the earnings of the company. In 1886 to September they were £1,679, in 1887 £2,263, in 1888 £3,529, in 1889 £4,053, and in 1890 £4,539. In December, 1885, they had 725 10-candle-power lamps, 1,800 in 1886; 2,389 in 1887; 3,451 in 1888; 4,555 in 1889; 5,451 in 1890; 6,293 in 1891; and 6,613 in 1892. He thought that in itself showed a very satisfactory total in the working of the company. In addition to these lamps they had orders for 64 more at present, and he had no doubt when it became known they proposed to reduce the price from 10d. per unit to 9d., that they would go on increasing the number of lights very rapidly. They had 6¾ miles of circuit for supplying incandescent lamps, and about three miles of circuit for arc lamps. At Upperton they were clamouring for two or three miles At present they were not in the position to go to that expense, but he had no doubt it would be very remunerative. They had four engines and four dynamos at the works. They would see, on looking at the accounts, that they had not only paid off all the early losses but also the interest on the debentures, and had put by £600 odd on depreciation stock, and still had a small balance in hand. He would ask them all to believe with him that this company was in a fair way to progress.

Mr. J. G. LANGHAM seconded and the motion was carried.

Votes of thanks were accorded to Messrs. Harvey, Henderson, and Hammond, and to the chairman.

Mr. HOLLINS proposed that the sum of £250 be given to the directors for remuneration between December, 1890, and 1891.

Dr. COLGATE seconded, and the motion was carried.

Mr. LANGHAM proposed a resolution adopting an agreement (which he read) of May 30th, 1892, between the Eastbourne Electric Light Company, Limited, and Alfred Spalding Harvey, Alexander Henderson, and Robert Hammond. The agreement set forth the transfer of the business from the managers to the company. Mr. Langham said the object of the agreement was to avoid the necessity of reconstructing the company.

The CHAIRMAN seconded and the motion was carried.

Resolutions were passed authorising the creation of a first mortgage debenture issue of £25,000 at five per cent., and ordering the value of the undertaking to be stated in the company's account as of the value of £32,120 on December 31st.

Hearty votes of thanks to the secretary and engineer for their services were carried.

The India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.—A half-yearly general meeting of this company is to be held at Cannon Street Hotel on Thursday, the 7th proximo, at 12 o'clock noon, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend of 5 per cent., or 10s. per share, free of income tax. The company's share register will be closed from the 29th instant to the 7th proximo, both days included. A further issue of capital was announced in last Tuesday's papers, the numbers of the new shares to be 41,600 to 50,000.

Eastern Extension Telegraph Company, Limited.—This company announces that the coupon on their 5 per cent. Australian Government Subsidy Debentures due on the 1st prox. will be paid on and after that date by Messrs. Barclay, Bevan & Company. Coupons must be left three clear days for examination.

TRAFFIC RECEIPTS.

Western and Brazilian Telegraph Company, Limited. The receipts for the week ended June 24th, were £2,792.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, June 23rd.	Closing Quotation, June 30th.	Business done during week endin June 30th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	...	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88½	88 — 89	88⅜	88⅜
2,849,510*l*	Do. do. Deferred	Stock	10⅜— 11¼	10⅜— 11¼	10⅜	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¼— 10⅜	10¼— 10⅜xd	10⅜	10¼
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	103 —107xd	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞— 3⅛	2⅞— 3⅛	...	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2⅛	2⅛— 2⅛	2 5/16	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3¼— 4¼	3⅜— 4¼	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3¼	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	10⅛— 10⅜	10⅛— 10⅜	10⅜	10 3/16
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160xd	155 —160	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛— ⅜xd	⅛— ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3⅝	3½— 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛— 11⅜	11⅜— 11⅝	11 11/16	11¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞— 15	14⅞— 15	15⅛	14⅞
70,000	Do. 6 p. c. Preference	10	15¼— 15⅜	15¼— 15⅜	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	108 —111	108⅜	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	108⅜	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	15
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	103 —106	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	102 —105	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5¼— 5⅜	5¼— 5⅜	5⅜	5 1/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000 ... ...*	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1⅜— 1⅝	1⅝	1⅜
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2⅜— 2⅝	2⅝	2⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1 — 1¼	1¼— 1⅜	1¼	1 1/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10⅛— 10⅜	10⅛— 10⅜	10⅜	10 3/16
180,042	Do. do. 6 p. c. Preference	10	15⅛— 15⅜	15⅛— 15⅜	15 5/16	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	18¾— 19¼	19	18⅞
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅞— 8¼	7⅞— 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10¼xd	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	20 — 21	20⅞	20¼
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	105	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	40 — 42	41⅛	40½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3¼— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 1/16— 3 1/16	3 1/16— 3 1/16	3⅛	3⅛
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 1/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	107 —110	109	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)*	10	6⅞— 7¼	6½— 7	7 3/16	6⅞
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞— 5⅛	4⅞— 5⅛	5 1/16	4 15/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¼— 13⅜	13⅜— 14¼	13⅛	13⅜
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12⅝— 13⅜	13⅛	13
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 —111	107 —109xd	110¼	109⅝
250,000*l*	Do. (issued at 5 p.m., all paid)	...	105 —108	104 —107xd	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	6½— 7½xd	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8⅜	8¼— 8⅜	8¼	8¼
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞— 8¼	7⅞— 8¼	8⅛	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¼— 3⅜	3¼— 3⅜	3½	3 5/16
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	45 — 47	46	45½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1½— 2½	1½— 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95xd	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	100 —103	101⅞	101½
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3¼— 4½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	104 —108	101 —105xd	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8⅜— 9¼	8⅜— 9¼	8 15/16	8⅞
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅝	6 5/16
30,364	Do. do. do. 5 p. c. Deferred	7½	2¾— 3¼	2¼— 3¼	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1¼— 1½	1¼— 1½	1¼	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½— 10	9½— 10	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —109	102 —106xd	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 6⅝	6½— 6⅝	6⅝	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅛—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20⅛.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid 2⅛—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—⅜.—£5 Preference (fully paid), 2⅛—3.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT,—2 per cent. (April 28th, 1892).

LEGAL.

Lane-Fox v. The Kensington and Knightsbridge Electric Lighting Company, Limited.

THE APPEAL—JUNE 27TH.

IN the action of Lane-Fox *v.* the Kensington and Knightsbridge Electric Lighting Company, Limited, the plaintiff, on Monday, appealed in person to Lords Justices Lindley, Lopes and Kay, sitting in the Court of Appeal, from the judgment delivered in the case by Mr. Justice A. L. Smith in March last, after a long hearing, bearing upon an alleged infringement of plaintiff's letters patent in electric lighting.

Mr. LANE-FOX, in opening his case, apologised for his personal appearance, in preference to instructing counsel, saying he had been advised to take this course by an eminent firm of solicitors. He hoped not to trespass on their Lordship's forbearance too much in appealing against a judgment arising out of an action for the infringement of his letters patent in electric lighting, dated October 9th, 1878. This judgment found that his patent was invalid, by reason of what the learned judge considered to be fatal; the disconformity between the provisional and final specifications, and also by reason of the learned judge finding there was not sufficient information to enable a workman to carry the invention into effect. His Lordship found several points in his (the plaintiff's) favour, among them being that the invention was one of considerable importance, and that he (the plaintiff) had been able to get over certain difficulties, it was a proper subject matter for a patent, it was not anticipated, and that defendants had infringed it. He would first deal with the subject of Mr. Justice Smith's reference to an unexplained delay in bringing this action. He was at a loss to understand why his Lordship thus dealt with the subject, because he (plaintiff) explained it to the best of his power, and expressed his willingness to answer any further question on the point. Perhaps what he had to say might better be explained in a sketch of the history of his invention, and how this case came to be brought before the Court. In 1878, the date of his patent, there had been considerable enquiries into the whole question of electric lighting. The electric arc had already become known as distinguished from the incandescent lamp, which had been introduced for all practical purposes, and generally the subject of dealing with the electric current had been greatly improved; but many scientific men were of opinion that much had yet to be done. They, however, thought it was impossible so to divide or sub-divide the current without such very great loss as for all commercial purposes to put it out of account. At this time, he (plaintiff) was working out a system of lighting and extinguishing gas lamps by electricity. He had taken out a patent, and had tried the experiment in Pall Mall for several months with the approval of the authorities. His researches had convinced him that electricity had yet to overcome great difficulties if it was to be applied to electric lighting on a commercial scale; and, as the result of his investigations, he came to the conclusion that to have electric pressure available at distant points was a new idea which he believed had not only not been conceived before, but was actually contrary to what till that time had been generally believed to be possible. Mr. Justice Smith had said as much in his judgment, as he proceeded to show by quoting from that document; and he went on to say that his Lordship stopped his (the plaintiff's) enquiry into the novelty or ingenuity of the invention, and particularly that part relating to his secondary batteries. Consequently his counsel was stopped in putting questions as to the breadth and originality of the idea. That, he thought, was not disputed by the other side, whose defence was chiefly a technical one. The reasons for the delay were that the subject was so new that there were few electrical engineers or electricians who were able to understand it properly. The industry thus had to be established, and an industry, too, so large that, as their Lordships, perhaps, knew, there were now many millions sterling invested in the distribution of the electric light. Seeing that he (the plaintiff) was one of the pioneers of this industry, his difficulties would be easily understood in getting men for the purpose, not that he meant there were none capable of understanding it, but most of these were engaged by firms occupied in the work at very high salaries. The practical effect was that he had to create new men. For instance, in regard to the production of incandescent lamps, which depended to a large extent upon the skill of the glass blower, he had to spend from £4 to £7 a week for men who now could be found at about £1 a week, and in larger numbers than were wanted.

LORD JUSTICE LINDLEY said he did not understand the learned judge to deal prejudicially with the plaintiff on this point; and he thought plaintiff need not trouble the Court on that score.

Mr. LANE-FOX thereupon, by the aid of a diagram, of which he handed copies to the Bench, proceeded to give a general idea of what his invention was, his broad idea being that his mains might ramify throughout a district, and that when he spoke of pressure being constant, the term was relative, not absolute. The energy of the dynamo might be subjected to variations, something perhaps being due to the boiler, or to pressure, or to variations in the main itself, so that it would not be sufficient to rely upon the skill or discretion of the attendant alone in regulating the power delivered by the engines to the dynamo. These variations might take place suddenly, or while the attendant was not watching. To this end he had shown two secondary batteries, but in the body of his specification he spoke of the desirability of having several, to be available whenever wanted, to keep the pressure constant. In passing, he might say that he never ought to have claimed for the lamps, but the matter was not at the time entirely in his own hands, and in the result it was now disclaimed. So that no very great importance attached to this, except as far as the novelty of the idea added to the probability that the invention was also new; and there was evidence on the shorthand notes that the lamps were the embodiment of a new idea.

LORD JUSTICE LINDLEY said that he thought Mr. Lane-Fox had better proceed at once to the consideration of the first point the learned judge had found against him.

Mr. LANE-FOX, bearing in mind what Lord Justice Lindley had said, proceeded to deal with the question of disconformity between the provisional and the final specification, without going into further explanations of the action of the system. He said that he had thought it better to make explanations first, so as to put their Lordships into possession of the facts, which perhaps he could do as they went along.

LORD JUSTICE KAY said that the first point for their consideration was the difference, which Mr. Justice Smith considered fatal, between the provisional and the final specification, as amended.

Mr. LANE-FOX agreed, saying that that depended partly on a conflict of evidence, and partly upon a misconstruction of certain facts which were not disputed. Speaking, after certain preliminary remarks, Mr. Justice Smith said, "The provisional specification, reading it most favourably for the plaintiff, can only be read to claim for the invention of using secondary batteries, the keeping of the electromotive force constant." In the first place, he (Mr. Lane-Fox) wished to point out that the provisional specification did not claim anything at all; it was not necessary that the provisional specification should make any claim.

LORD JUSTICE KAY: It is only necessary that it should describe the invention.

Mr. LANE-FOX said that the whole of what Mr. Justice Smith said on that page assumed that the claim must be clearly set forth in the provisional specification, not merely the description, but the claim for the particular advantages which were offered by the combination. Perhaps he had better read that part of it. "The provisional specification, reading it most favourably to the plaintiff, can only be read to claim for the invention of using secondary batteries, the keeping of the electromotive force constant. I have no doubt that in the complete specification, as originally filed in April, 1879, the words 'regulating the electric current,' were solely to the electrometer. What has been done is this: Upon discovering the electrometer on July 20th, 1883, it was sought to apply the words 'regulating the electric current,' which had been theretofore applicable solely to the electrometer, to secondary batteries, so as to claim for them, not only the power of keeping the force constant in the mains, but of regulating it therein." Mr. Justice Smith suggested that there was a difference between the idea of regulating the pressure and keeping it constant. He (Mr. Lane-Fox) failed to follow that distinction: he could not conceive how there could be any difference between regulating the pressure and keeping it constant. Mr. Justice Smith further said: "The question is, does the plaintiff now claim for the same invention in his complete specification as it stands, as he did in his provisional specification? I say he does not. In the provisional specification he claimed as his invention the use of secondary batteries in aid of the dynamo, to keep the E.M.F. in the mains constant, whereas he now, by his amendment of his complete specification, claims as his invention the use of secondary batteries, not only to keep the E.M.F. constant in the mains in aid of the dynamo, but also to regulate the E.M.F. in the mains for the benefit of the lamps." He (Mr. Lane-Fox) could understand the distinction between the benefit of the dynamo and the lamps—the object was to have an even pressure in the lamps and the mains.

LORD JUSTICE LINDLEY: You say keeping the electromotive force constant involves regulation.

Mr. LANE-FOX said it was another word for the same idea.

LORD JUSTICE KAY: You described in your provisional specification, and in the complete specification, two modes of keeping the electromotive force constant; one was by the aid of the secondary batteries in the mains, another was by the aid of the electrometer, which was connected with machinery, which would diminish or increase the steam, running the dynamo quicker or slower. Running the dynamo at a regular speed was one mode of keeping the pressure constant. The secondary battery was another mode of keeping the pressure constant. Is not that so?

Mr. LANE-FOX said that was so. The original specification, as well as the final, contemplated a possible variation in the number of lamps in use, and he never for a moment thought that the dynamo would not require regulating according to the amount of work expected of it, but both in the provisional and the final specification, he explained the means of mechanically automatically regulating the steam pressure according to any variation of the pressure in the mains. That he thought at the time was important, because he attached an undue importance to it, as was clearly shown by the fact that he made use of the word "necessary." He found, later on, that the secondary batteries worked, as a rule, with such great efficiency, that the automatic regulation of the steam was quite superfluous.

LORD JUSTICE KAY: Do you mean that supplied any deficiency which was occasioned by an alteration of speed of the dynamo?

Mr. LANE-FOX: No; in the event of either the engines varying through the pressure changing, or in the event of the pressure in the mains varying.

LORD JUSTICE KAY: And the speed of the dynamo?

Mr. LANE-FOX: Although the speed of the dynamo might be kept constant, the pressure in the mains might vary from a variation in the number of lamps in use?

LORD JUSTICE KAY: It might also vary from the variation of speed in the dynamo. Would your secondary battery supply any of the deficiency occasioned by that variation?

Mr. LANE-FOX: Certainly. The secondary batteries supply any deficiency in the pressure of the mains, whether occasioned by an alteration in the speed of the dynamo, or by lamps being put on or off. The degree to which they were useful in that direction was a matter of dispute. My witnesses—very eminent men—were consistent on that point, they said they were extremely valuable in that respect. The defendants' witnesses said they might be useful, but without switches they were of very little commercial use.

LORD JUSTICE KAY: You will have to explain to me what switches mean in that connection.

Mr. LANE-FOX: Quite so. I want to point out that the arrangement in the provisional specification, and in the final, are precisely identical, but in the final specification I go into detail in describing the action of the secondary batteries, and I speak of their charging and discharging according to a variation in the mains which I do not mention in the provisional. In the provisional they are said to be arranged between the main and the earth, to act as a reservoir of electricity. It is by virtue of their function of reservoirs that they are able to supply a deficiency or to take up an excess. The scientific question as to their efficacy in this respect is a matter on which I shall have to occupy your Lordships for some time unless your Lordships say that a small amount of advantage is sufficient. But if your Lordships say, as Mr. Justice Smith said, that the advantage was so small that it was doubtful how far it was of commercial value, I shall have, of course, to compare the evidence on both sides, and ask leave to call rebutting evidence. The Attorney-General offered to do that, and unfortunately Mr. Justice Smith said that he had had plenty of it.

LORD JUSTICE KAY: You had had 15 days before Mr. Justice A. L. Smith.

Mr. LANE-FOX said the subject was new to that learned judge, and the last witnesses seemed to have influenced his mind more than the first, and he was taken very much by the idea that although batteries might be useful to a certain extent, as the other side admitted, yet for commercial purposes they were not sufficiently useful without the addition of switches.

LORD JUSTICE LINDLEY: He thought you failed to make out that the secondary batteries would keep the main constant without the switches.

Mr. LANE-FOX said that would depend on whether he (Mr. Lane-Fox) meant by "keeping the pressure in the mains constant," absolute constancy. Of course he did not; because he spoke in the provisional specification and in the final of the importance of keeping the pressure in the mains as nearly as possible constant. Secondary batteries could not keep the pressure absolutely constant.

LORD JUSTICE KAY: Your first point is, that the function of the secondary battery, as described in the provisional specification, was a function or regulation of the current, and Mr. Justice Smith says it was not.

Mr. LANE-FOX: Mr. Justice Smith makes a distinction between keeping the pressure constant and regulation.

LORD JUSTICE KAY: We want to hear from you that he was right or wrong.

Mr. LANE-FOX said he was unable to follow the distinction at all. Mr. Justice Smith said in another part of his judgment, "Anxious as I am to read the specification in favour of the patentee, I cannot do so without seeing that Mr. Lane-Fox, when he drafted it in April, 1879, had in his mind, as regards the matter now in hand, two separate and distinct ideas. The one was, that by coupling up secondary batteries to his system of distribution of electric current he might be able to neutralise the pressure of the mains and thus render constant the electromotive force therein (this would be in aid of the dynamo, as Prof. Perry stated); the other was to regulate such electromotive force in the mains (and this, as it seems to me, was for the benefit of the lamp). These ideas are separate and distinct."

LORD JUSTICE KAY: Does he mean by neutralising, keeping constant?

Mr. LANE-FOX: I fail to follow it. Neutralising would mean doing away with the pressure in the mains.

LORD JUSTICE KAY: He cannot mean that; he must mean equalising.

Mr. LANE-FOX said he could not accept it as a mistake for equalising. He would have put that interpretation upon it if he had not found it in Sir Horace Davey's speech, and that learned counsel said that he had used it advisedly.

LORD JUSTICE KAY: You tell us that (whatever was the cause) if the voltage in the mains fell, say, below 100, either from the dynamo running slowly or anything else, the secondary battery would supply the deficiency.

Mr. LANE-FOX said they would, or they would tend to do so. This was important, because, unfortunately, the Attorney-General did speak of their doing so absolutely, and Mr. Justice A. L. Smith fastened on to that. He said: "The Attorney-General in opening the case stated—It is not saying too much, my Lord, to say, as skilled electricians will tell your Lordship, that, remarkable as it may be, every system of modern successful electric lighting which proceeds from generators, dynamos, and which is absolutely maintained at a constant pressure—what I call automatically maintained, without other devices for keeping the current constant—is an exemplification of Mr. Lane-Fox's discovery and system." Absolutely maintaining the constancy and pressure, he admitted was too strong. His specification did not say anything of the kind; that spoke of the pressure being kept as nearly as possible constant, and it also spoke of the variation in the pressure causing the batteries to charge and discharge. And when Mr. Justice Smith said that, he thought that learned judge had in his mind that he was claiming too much. Probably the Attorney-General put it in that way only wishing to put strongly the importance and value of his (Mr. Lane-Fox's) system. The Court would see there must be a variation, and all he claimed was that the presence of the batteries very materially reduced that variation, and made the light more constant than it would be otherwise. The question of switches was an improvement or addition which he himself devised afterwards for the purpose of making a small battery regulate or keep the pressure constant, instead of a large one. Mr. Justice Smith said that he did not think a workman would understand without explanation what "very large," as applied to the surface of cells, meant.

LORD JUSTICE KAY said that was a separate point.

Mr. LANE-FOX said he was trying to make the Court see that he had never in the final or provisional specifications claimed anything like a constant pressure, but merely that it was to be kept as nearly as possible constant, and that batteries were a means to that end, and that the presence of batteries enabled the attendant to vary the speed of the engines at leisure. His point was this, that although there might be a difference in the way in which the function of the secondary batteries in the final and provisional specifications were described, yet the connection or arrangement was practically the same. The secondary batteries were mentioned in the provisional specification, and they were mentioned in the final in precisely the same combination, but the words relating to their action were amplified and extended there.

LORD JUSTICE KAY: The learned judge says you do mention them, but you mention them, as he thinks, not as being used for regulating, but to keep the pressure constant—whatever the difference may be. You say there is no distinction.

Mr. LANE-FOX: Quite so. I say there is no distinction. The next point in the judgment was that of sufficiency of specification.

LORD JUSTICE KAY: I am trying to apply my mind as to whether there was an essential difference between these two specifications. That is the first point against you.

Mr. LANE-FOX read several passages from the provisional specification.

LORD JUSTICE KAY: You say the electromotive force must be kept constant in the mains at as nearly as possible 100 volts.

Mr. LANE-FOX said that was a point which was made a good deal of by his opponents. He spoke of keeping the electromotive force constant by having several generators, and also by an electrometer arrangement, whereas in the final specification the functions of the secondary batteries for keeping the pressure constant was emphasised. In the provisional specification, when he got to that point, the secondary batteries were not mentioned in that connection. He admitted that it would have been better if it had been in the provisional specification, but he had already spoken of their combination, and he did not lay much stress upon them for keeping the pressure constant in that particular place.

LORD JUSTICE LINDLEY: You say here it is necessary to have a further regulator, which you afterwards explained by turning it into an electrometer.

Mr. LANE-FOX said that he found afterwards in practice that this electrometer was not necessary; that the automatic regulation of the steam could be dispensed with, and therefore he cut that out. He admitted the expression "necessary" to use such a thing was too strong, and one that he regretted having used, but that he altered by disclaimer.

LORD JUSTICE KAY: The learned judge has construed this original specification in your favour so far. He treats you in the provisional specification as having mentioned secondary batteries for the purpose of rendering constant the electromotive force in the mains. Your provisional specification seems to be this: You state, as a general proposition, that it is important to keep the pressure in the mains constant; then you say a secondary battery may be used as a regulator; and then you describe an application of the electrometer which will regulate the speed of the engine and dynamo.

Mr. LANE-FOX: Quite so.

LORD JUSTICE LINDLEY: What do you claim now it is altered.

LORD JUSTICE KAY: You strike out the electrometer.

LORD JUSTICE LINDLEY: What was your first disclaimer?

Mr. LANE-FOX: I struck out the lamps, then the electrometer, and then I struck out the particular way of conveying the current and measuring it.

LORD JUSTICE LINDLEY: You say, although you said in your provisional specification it was necessary to have an electrometer, you found it was not, and then you struck that out.

Mr. LANE-FOX: It is striking out one of the means.

LORD JUSTICE LOPES: I do not suppose that would make any difference if you do not call it necessary. Suppose you call it necessary, and before you file your final specification you find you can do without it, as at present advised, I should hardly think that was disconformity: it looks to me rather a new discovery to that extent, but still an improvement within the original idea.

Mr. LANE-FOX: That is how I ask your Lordships to read it.

LORD JUSTICE KAY: What the learned judge has put against you is this: "Upon disclaiming the electrometer on July 30th, 1883, four years after the complete specification, it was sought to apply the words 'regulating the electric current,' which had been theretofore applicable solely to the electrometer, to secondary batteries, so as to claim for them, not only the power of keeping the force constant in the mains, but of regulating it therein." What is the difference between keeping it constant and regulating, I do not understand?

Mr. LANE-FOX: I am unable to follow that.

LORD JUSTICE KAY: I should have thought that keeping it constant was regulating.

LORD JUSTICE LOPES: It seems to me that keeping it constant was one of the most ordinary means of regulating.

LORD JUSTICE LINDLEY: Although it is a technical point, it is an important one. I understand the view you submit is this: In your provisional specification you say that the intention of your invention is to have a constant electromotive force in the mains. You say that to do that you must do two things—have several generators, and have electrometers. Then you say you find by experience you can do without electrometers, that they were things you thought necessary, but you found they were not; but your intention was constancy of the electromotive force.

Mr. LANE-FOX: That is what I am suggesting.

LORD JUSTICE LOPES: You say that after experiment you found that the electrometer was not necessary.

Mr. LANE-FOX: Yes.

LORD JUSTICE LINDLEY: And you say it does not affect your invention.

Mr. LANE-FOX: I say it does not.

LORD JUSTICE KAY: The next point is that the invention would not work.

Mr. LANE-FOX said the action of the secondary battery was one which their Lordships could not expect to understand without a great deal of explanation and the authority of expert witnesses. He had on that point a good deal of criticism to make on the evidence of the other side, but the simple question he wanted to submit was, assuming they would work and his evidence was correct, was there sufficiency of specification to enable them to be carried into effect?

LORD JUSTICE LINDLEY: Where do you tell a man how to do it?

Mr. LANE-FOX said that he spoke of the connection between the main and the earth, and the point was whether these batteries would be used so that they were sufficiently large and have sufficient force available to keep the pressure constant in case of fluctuation. He held that that must be a matter of experience on which no amount of specification would be sufficient to a person who knew nothing about it.

LORD JUSTICE LINDLEY: You say that "The cells should have a very large conducting surface, and there should be several batteries connected up at various points of the mains, so that by increasing the electromotive force during the hours when not much electricity is being used, they will become charged, and the electric force will be stored up in them so that a sufficient supply will be available when the electromotive force falls owing to the draft from the mains when the force is most used and needed. The number of cells in each of these batteries will depend on the electromotive force of the mains."

Mr. LANE-FOX: I speak of 100 volts, but that is only a suggested pressure.

LORD JUSTICE LINDLEY: You say the cells should have "a very large conducting surface"—what does that mean?

LORD JUSTICE LOPES: Would not that depend on the particular circumstances?

Mr. LANE-FOX: I think so, and I think that would be within the experience of any practical engineer.

Mr. JUSTICE KAY: It would depend on the number of lamps?

Mr. LANE-FOX: Quite so, and you will judge of the variation as permitted. The Board of Trade have fixed 4 volts above the hundred and 4 volts below the hundred.

LORD JUSTICE LOPES: You say it would be very difficult to lay down any definite size which might be generally adopted.

Mr. LANE-FOX: I say that must be left to the discretion and judgment of the electrician of the circumstances of the case. If you have a large surface in a cell it will accumulate and store a large quantity of electricity at a given pressure. Broadly speaking, the capacity of a battery to store energy is directly proportionate to the extent of surface. That was well known in 1878.

LORD JUSTICE LOPES: May I paraphrase it this way, that the cells should have a conducting surface as large as you can afford to make them.

Mr. LANE-FOX: Quite so. I have evidence to that effect.

LORD JUSTICE LINDLEY: Do you say that there is some evidence that you tell the workman that the surface of the cells should be as large as he can afford to make them?

Mr. LANE-FOX: Certainly. There is an overwhelming amount of evidence on that point. Plaintiff, then turning his attention to the question of sufficiency, said several witnesses of great importance appeared on his side to prove that he had given sufficient evidence that it could be carried into effect, and this was not contradicted on the other side; on the contrary, Sir Frederick Bramwell said sufficient directions had been given for any workman to carry it out, but he did not think it would be commercially useful. That was not the point, Sir Frederick said. He did not dispute the value of the suggestions, but because, with this, his (plaintiff's) own witness, Prof. Barrett, said in order to arrive at the size itself he should like to make quite justifiable experiments. Mr. Justice Smith seemed to have regarded this as decisive, and becoming impatient, they had to pass from this part of their case.

LORD JUSTICE LINDLEY said he understood the learned judge to say that even the most eminent men spoke all in the same direction.

Mr. LANE-FOX said after that expression of opinion he would pass to his next point—the action of secondary batteries. These, defendants said, could not be of practical utility without the use of switches, but his case was, that the work could be done without switches; and he complained that certain evidence of Mr. King—which was not founded on fact—evidently had an undue influence on the opinion of the learned judge in summing up; and he proposed to call witnesses to prove this misapprehension.

LORD JUSTICE LINDLEY (the time having arrived for the rising of the Court): Which you can do to-morrow morning.

JUNE 28TH.

On Tuesday Mr. LANE-FOX, resuming his address, said when he left off the previous evening, he proposed to deal with the question whether his invention, as applied for in the specification, was practically useful or not, and to consider the question of switches in connection with the question of secondary batteries. The evidence upon this point occupied, he believed, some 10 days out of the 15 of the hearing of the case, the point being how these secondary batteries act. The witnesses on his (plaintiff's) side were very eminent men, indeed, and of the greatest scientific attainments, with great practical experience, and none of them had any commercial interest in the matter, as he believed, as a matter of fact, those on the other side had. That evidence of his was clear and consistent; whether or not it was sufficient, he would ask their Lordships to consider afterwards, as he would the question of earth, on which the learned judge found in his favour, and so he did not propose at this stage to trouble their Lordships on that point. As to the evidence on the other side in reference to these secondary batteries, he was taken totally by surprise, and the Attorney-General offered to rebut it, but the learned judge did not seem to think it worth while. Should their Lordships desire to hear additional evidence on the point, he was prepared to give it.

LORD JUSTICE LINDLEY said the Court did not usually pursue that course.

Mr. LANE-FOX said he would simply say that if there was any doubt in their lordships' minds, perhaps they would allow him to call this additional evidence. The evidence on the other side was, in many ways, confused, conflicting, and, for the most part irrelevant. It embraced, so he understood, two separate lines of argument: (1) That the battery connected as described in his specification would help keep the electromotive force constant to some extent; but the other side said that whereas their object in using secondary batteries was chiefly for the purpose of storage, this regulating effect was of secondary importance, and without the use of switches arranged for varying the number of the cells it would be difficult to get sufficiently large storage capacity in the batteries, and therefore it was not of the commercial value in the way described. The switches, as he first introduced them, enabled the use of a battery which came into the market. Everybody was agreed that Planté's original well-known batteries had been departed from by developments in the exigencies of manufacture, and he had overwhelming evidence of the practical utility of his invention. The second line of argument of the defendants was based upon an isolated statement of Mr. King, which he believed was entirely incompatible with the opinion of any electrician of any standing whatever, to the effect that connecting these batteries up led to no variation whatever, but, on the contrary, created a variation which otherwise would not be. At the moment he thought that Mr. King's cross-examination would entirely and completely destroy all that he had put forward; but it seemed the Attorney-General did not think it worth his while to pursue the matter. He (the plaintiff) now only referred to it because it seemed to have influenced somewhat the opinion of the learned judge hearing the case; and he would point to the evidence of Sir F. Bramwell on the point, as justifying his (plaintiff's) contention; and further, as dealing with his (plaintiff's) next submission, bearing upon the action of the curve on the action of secondary batteries. This he illustrated by a diagram, and having described the difference between Planté's method and his own, and his submissions on this part of the case, he passed on to consider his evidence on the question of utility, saying (in response to an observation by Lord Justice Lindley) that his case was that, whatever importance was attached by defendants to this point, they used his system.

If, added the learned LORD JUSTICE, this were proved, the question, as he understood plaintiff, did not arise whether or not it could be worked with commercial profit.

On that point, said Mr. LANE-FOX, he could have given, and could now give, a large body of evidence, and, indeed, the Attorney-General offered to give rebutting evidence, but the learned judge who, not unnaturally, began to tire of the case, said he thought they had heard enough.

The LORDS JUSTICES having said they could not receive rebutting evidence except under special circumstances,

Mr. LANE-FOX went on to consider the evidence as to the charge and discharge of the batteries, submitting that some of the testimony taken on that point was not relevant to the questions at issue, and as to the other part, that he proved you could charge and discharge without injuring the cells, and that, whatever might be the defendants' experience in their working of a modification of Planté's process, Prof. Barrett proved the use of one of plaintiff's for six years without deterioration, and, indeed, that it remained in wonderfully good condition. In the course of upwards of an hour's discussion of this part of the case, Mr. Lane-Fox copiously quoted from a number of the other witnesses, with the view of showing that, contrary to the case of the defendants, the batteries charged and discharged, apart altogether from the question of keeping them in health by daily discharging them with a large current, there was, in fact, nothing in the evidence to justify that finding.

Mr. LANE-FOX, dealing with the question of charging secondary batteries, said that his specification referred to secondary batteries such as Planté's. Secondary batteries had all approximately the same kind of action, but cells might vary in the amount of potential they required for charging.

LORD JUSTICE KAY said that he wanted to know what the evidence on both sides was.

Mr. LANE-FOX said that the point was this: The witnesses on his side all said that a small potential difference would cause the batteries to act so as to store and discharge, that the coupling up arrangement with the mains caused them to prevent fluctuations of the electromotive force in the mains which would otherwise be the case. The defendants said that they wanted to use the secondary batteries in order to get their full storage batteries utilised, and in order to do that they were obliged to put through them currents which were of a certain strength and which raised the voltage per cell up to a certain point, and in order to do that switches were used. That was true but it was irrelevant. It was true that you might show curves and experiments which indicated that a certain current would cause the potential of the battery to rise. It was not disputed by the other side that the charge got into a battery at a certain difference of potential would vary directly with the surface of the battery, that was to say that twice the surface of

the battery would take in twice as much current at a certain potential difference as half that surface. His point was this, that if you had a battery connected with the mains, the dynamo would cause the electromotive force in those mains, and by no possibility could the batteries make the potential higher than that which the dynamos would make it. That was the essential point. He submitted that the evidence of the other side did not disprove his contention that batteries made as in 1878 were capable of receiving a charge with a small potential difference; that even cells made of a modern type would receive a small charge of a small potential difference, but not a charge which was anything in proportion to their full storage capacity, because their full storage capacity was very great in proportion to their bulk. They had succeeded in condensing the size of the battery, so that you could get a large quantity of storage with a certain quantity of lead. On the other hand, in order to charge and discharge these cells to utilise their full storage capacity, a very much larger potential difference might be required than was contemplated in his specification. But he contended that these batteries, when they were connected with the mains, although they did not charge and discharge to anything like their full storage capacity, helped to keep the pressure constant.

LORD JUTICE KAY said the difficulty the learned judge put was, that unless the generative force was increased above 100, say to 110, the batteries could not be charged so as to make them useful.

Mr. LANE-FOX said that it was not disputed that you could begin charging a battery when it was empty with a small potential difference, and it gradually rose.

LORD JUSTICE KAY said he understood that, but you could not charge it sufficiently to make it of any use.

LORD JUSTICE LINDLEY said he understood Mr. Lane Fox's contention to be that the defendant's cells stored more in a small space than Planté's, and a higher difference might be necessary for them, though not for Planté's.

Mr. LANE-FOX: My point is this, that I have brought forward evidence to the effect that Planté's cells were used by Prof. Barrett.

LORD JUSTICE KAY: You have said that the Planté cells which you describe in your specification, having a very large surface is an advantage. Now, the object of making the lead porous and letting the fluid into all the pores of it, is to have a still larger surface.

Mr. LANE-FOX: For the purpose of storing, not for conductivity.

LORD JUSTICE KAY: Then there is a distinction from your specification between the modern style and the old Planté.

Mr. LANE-FOX said he spoke of the conducting surface, not the active surface. In the modern cells they desired to have a chemically active surface; his specification said conducting surface, which was a somewhat different matter. Conducting surface was spoken of there as being what was necessary in order to get a large storage with very small potential difference. But a large active surface condensed into a small space, they admitted would require a greater potential difference to charge and discharge than a large conducting surface. With regard to the question of switches, in these batteries now used by the defendants, they found it convenient to alter the number of cells in series, so that they were able to get a greater range of charge and discharge without varying the actual number of cells.

LORD JUSTICE LINDLEY: You say that these switches are merely a useful adjunct which do not affect the question of infringement or non-infringement.

Mr. LANE-FOX: Yes.

LORD JUSTICE LINDLEY: I think you might leave the switch business to your opponents. You say that the infringement consists in the fact that they use your secondary batteries.

Mr. LANE-FOX said that the fact that the defendants for their purpose would require to vary the number of cells was a secondary detail which was the result of experiment.

Mr. WALLACE, for the defendants, asked the Court to look at the specification, which spoke of the use of "a number of secondary batteries such as Planté's lead and sulphuric acid. He said that all the batteries which were mentioned in the trial were batteries of that description, but the evidence was that with the Planté battery, pure and simple, the plaintiff's invention could not be worked out. The defendants' was not a system intended to work on a small scale; it was a large system, intended to be worked on a large commercial scale, consequently large batteries were required. To prove infringement, it was not sufficient theoretically or scientifically to be able to charge in a laboratory batteries with a variation of 1 volt. To a certain extent it was a commercial question, and no doubt it was true that a certain amount of electricity would flow when the potential in the main was raised above the potential in the battery. But the learned judge said that unless you raised that up very much above the potential which would smash the lamps, you could not get the proper charge into the batteries, and in addition to breaking the lamps, you would have the batteries destroyed. The point of experiments on behalf of the defendants was that, in order to get to 100 volts in the batteries in actual practical work, the potential in the mains must be raised to 115 volts. If the two things—the potential in the mains and the potential in the batteries—were left side by side, he had no doubt they would get eventually to the same potential; but it would take such a long time to do it, that the work on the circuit would be of no avail. Mr. Crompton made an experiment, in which he attempted to allow the current to go into the battery at 101 volts, with the result that in 20 hours he got in no appreciable current at all, only a very few ampères. What there was would have been discharged in the fractional part of a second. He did not say that the plaintiff's witnesses had no justification for the evidence they gave; but in order to get a practicable working system, they must charge up to the high potential he had mentioned to get in any current which would be of any practical use in electric lighting.

LORD JUSTICE KAY: That is for want of quantity, but you do not get the quantity by increasing the voltage.

Mr. WALLACE: No. My point is that you could not get your 110 volts without going up to 125. The learned counsel then went on to argue that Prof. Barrett's installation could not be regarded as practical, and that the original Planté batteries would not have been useful for Mr. Lane-Fox's purposes, because they would not have had a large enough conducting surface, and because the coating, having nothing to catch hold of, would have fallen off. He was referring to the evidence of Mr. Swinburne in support of this view, when

The hearing of the case was adjourned for the day.

The Brush Electrical Engineering Company, Limited, v. Kingsbury.—We have received from the Brush Electrical Engineering Company, of Margaret Street, Sydney, the following full text of Mr. Justice Manning's judgment in the above case, which came before the Equity Court in New South Wales:—This case was very fully discussed before me upon the motion for an interim injunction, which, beyond all question, should have been turned into a motion for decree, and so strongly did I feel as a matter of fact that all the materials were before me on the interim injunction for coming to a decision that I made the order with costs. Then it was open to the defendant to appeal, which he failed to do, and his appeal, if upheld, would have made him successful in the suit. On that occasion I was asked to give costs as between solicitor and client, and I declined to do so. I cannot imagine any case upon a motion for an interim injunction when such costs would be given, and I mentioned that the question of such costs would be one for the hearing. It seems to me that if ever there was a case for an order as asked for, this is one. Here is a patent which has been established by the decisions of the Court of Appeal, in England. Letters of registration were procured in this colony, and the defendant acted for five years as agent for the company owning those letters of registration. Subsequently there was an assignment to another company, and eventually to the plaintiff company, and the defendant ceased to be agent. Then, that being so, the defendant becomes agent in this colony for lamps, which, beyond all question are an infrigement of the patent rights of the plaintiff company and of those people for whom he had been acting as agent. He admits infringement in the first instance and appears to have had sufficient knowledge on the subject by paying a royalty for the importation of these very lamps which he says now are not an infringement. He is warned over and over again. He takes no notice of the warnings, and when the matter comes on for hearing he is compelled under the rules of court to deliver particulars of his grounds for impeaching the patent; these grounds are not supported. I have no doubt that there was a very fair point of law, and it appears to me it would have been a most disastrous thing to have decided that in any other way than the manner in which I decided it on the injunction motion, and there is nothing new to induce me to alter my views. I must treat this case as one in which the only defence set up has been abandoned. I must look at that defence as showing the whole character of the defence to the suit. Edison having applied for and obtained a grant, and patent rights in England early in November, 1879, applies for letters patent out here, and at that time beyond all question nothing whatever in these colonies was known of this discovery, but between that time when by law he was compelled to disclose his invention and the time of his receiving letters patent, there was an account of the invention in the newspapers, by reason of an application made elsewhere, particulars of the invention appearing in the English newspapers, of which copies were published here. This defence is put forward by a man who has been the agent if not for the plaintiffs, at least for their predecessors in title. Every obstacle has been thrown in the way, even to compelling a commission to be sent to England to prove the incorporation of those companies. It is to my mind as bad a case of infringement of a patent as I have ever heard of, and I think, therefore upon every ground that I am bound to make a decree as asked in the terms of the 1st, 2nd, 3rd, 5th and 7th paragraphs of the prayer of the statement of claim. I think also that it is a very reasonable request that the defendant should make an affidavit within seven days of all the lamps in his possession, control, and custody referred to in the 3rd prayer of the statement of claim, within seven days from the service upon him of notice of a decree having been made in the suit, and of this special order; and further that he deliver up all such lamps as come within the description of the 3rd paragraph of the prayer within four days after service of the decree. And I also think that for the purpose of the enquiry as to damages before the Master he should make a discovery, under rule 122, of all documents which he has or has had in his possession or power within fourteen days after the service of the decree.

The British Association of Medical Electricians v. Moffat.—In the Chancery Division of the High Court of Justice yesterday, before Mr. Justice Chitty, the case was mentioned of the British Association of Medical Electricians *v.* Moffat, which came before his Lordship on a motion for an injunction to restrain the defendant from advertising, or otherwise representing, that he was a member of the British Association of Medical Electricians, until the trial of the action or further order. His Lordship now indicated to Mr. Byrne, Q.C., counsel for the plaintiffs, that he did not think an order could be obtained on the motion, as it was more a question of fact than anything else. He suggested that the matter should stand over until the trial of the action. Mr. Levett, Q.C., for the defendant, was willing to give an undertaking not to print any more circulars or advertisements, claiming that his client was a member of the plaintiff association, it being understood, however, that he was at liberty to issue existing circulars and advertisements. It was then agreed that the motion should stand over until the trial of the action.

Akers v. Iliffe.—We are authorised to state that this action, a report of an interlocutory proceeding in, which appeared in our issue of June 3rd, has now been discontinued by the plaintiff, who has withdrawn all claims and charges against the defendant, and paid him the sum of £1,750.

NEW PATENTS—1892.

11,050. "Improvements connected with tubular electric conductors." D. COOK and E. PAYNE. Dated June 13th.

11,067. "Improvements in and connected with joining the ends of telegraph and of telephone and other wires, and in machines for preparing the said ends of the wires." W. A. PERRY. Dated June 13th.

11,071. "Improvements in electrical apparatus for scoring in billiards or other games, applicable also for showing the number of revolutions of marine and other engines, and for other purposes." W. SMETHAM. Dated June 13th.

11,085. "Improvements in electrical indicators." WOODHOUSE AND RAWSON UNITED, LIMITED. (Communicated by R. Varley, United States.) Dated June 13th.

11,087. "Improvements in galvanic batteries." W. L. WISE. (Communicated by T. Rosati, E. Righetti, and G. O'Connell, Italy.) Dated June 13th.

11,096. "Improvements in or relating to telegraphic instruments." A. C. MOLL. Dated June 13th.

11,104. "Improvements in telephonic apparatus." H. HAMMARLUND. Dated June 13th.

11,119. "Improvements in electric switches." F. BROADNAX. Dated June 14th. (*Complete.*)

11,126. "An improved element, by the aid of which a current of electricity may be generated." J. PATERSON. Dated June 14th.

11,147. "Improvements in secondary or storage batteries." H. H. LLOYD. Dated June 14th. (*Complete.*)

11,154. "Improvements in the method of welding metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated June 14th. (*Complete.*)

11,181. "An improved construction of electric alarm clock." W. PETCHEY. Dated June 14th.

11,192. "Improvements in and relating to the driving of dynamo-electric machines, and in apparatus therefor." T. REID. Dated June 14th.

11,194. "Improvements in indicating apparatus for high tension circuits." B. M. DRAKE and J. M. GORHAM. Dated June 15th.

11,277. "Improvements in electric current meters." G. A. GOODWIN and H. FOSTER. Dated June 16th.

11,302. "Improvements in electrical measuring instruments." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY and A. SOAMES. Dated June 16th.

11,316. "Improvements in or connected with electric alarums." G. W. VAN VIANEN. Dated July 16th. (*Complete.*)

11,320. "Improvements in telephonic apparatus." C. VOGT. Dated June 16th. (*Complete.*)

11,326. "Improvements in tubes or pipes for aeration, drainage and electrification for horticultural purposes." R. H. COURTENAY. Dated June 16th.

11,344. "Improvements in casing for cables and wires." F. B. NICHOLSON. Dated June 17th.

11,353. "Improvements in electrical alarum clocks." D. J. MULLARKY. Dated June 17th. (*Complete.*)

11,382. "An improved process for manufacturing compound and elementary bodies or chemical products by means of electricity, and apparatus therefor." H. NIEWERTH. Dated June 17th.

11,393. "Improvments in or relating to electric railways." F. WYNNE. Dated June 17th.

11,403. "Improvements in electric generators and motors." W. T. GOOLDEN and L. B. ATKINSON. Dated June 17th. (*Complete.*)

11,424. "Improvements in automatic telephone and other electric exchanges." G. C. DYMOND. (Communicated by A. B. Strowger, United States.) Dated June 18th. (*Complete.*)

11,426. "Improvements in or relating to indicating electric switches and current reversers. G. C. DYMOND. (Communicated by A. B. Strowger and W. S. Strowger, United States). Dated June 18th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

13,627. "An improved alternating electric current motor." W. B. BRAIN and A. J. ARNOT. Dated August 12th. The inventors provide a coil of wire, or compound solenoid wound spirally in the form of an annulus, and they conduct the primary or main current around the two halves of said spirally wound annular coil, or compound solenoid, in opposite directions, that is, so that if a magnetic core were included in said coil or solenoid such current would tend to form double north poles at, say, the top, and double south poles at the bottom. In close proximity to this spirally wound annular coil, or compound solenoid, they arrange another similar coil or solenoid, whose individual convolutions are so arranged as that at any given moment they will be approximat·ly parallel to the adjacent convolutions of the first-mentioned spirally wound annular coil. This said second coil or solenoid is mounted upon a spindle in such a manner as that it can revolve freely, whilst the first one is a fixture. A commutator is connected with this movable spirally-wound annular coil (or armature, as we shall hereinafter describe it) in order that its different sections may be automatically included in either the right or the left-hand half as it revolves so as to ensure the two halves of the armature, or revolving spirally-wound annular coil or compound solenoid, and the field or stationary coil being always in harmony with each other, *i.e.*, allowing the attractive and repelling forces to act simultaneously, so as to rotate the armature in the same direction. 5 claims.

13,936. "Improvements in and relating to electric motors, chiefly designed for use in connection with ventilating fans." C. J. KINTNER. Dated August 18th. In this invention, immediately the current is set up through the armature and the field coils, the magnetic effect of the cores upon the iron core of the armature, together with the lifting effect of the fans, is such as to retain the armature and all of its attached parts in an operative position, so that the attendant may now release his hold of the sleeve, and the armature will continue to maintain this position until it is pulled down again by grasping the sleeve. Should there be an increase of current through the motor, it will immediately regulate itself by the lifting effect of the fan which tends to lift the armature out of the field, the counteracting magnetic effect of the field cores upon the armature tending to act in turn as a brake thereon. 9 claims.

14,962. "Improvements relating to telephones." W. H. BROWN. Dated September 4th. Consists in providing the receiver with a portable ear shield of paper, cardboard, or other suitable material or substance to prevent contagion when placing the receiver to the ear of the listener. 2 claims.

16,989. "Improvements in printing telegraphs." H. H. LAKE. (Communicated from abroad by M. G. Farmer, of America.) Dated October 6th. The inventor employs an induction coil with primary and secondary circuits. The secondary circuit is connected to the main line over which induced currents only pass, and in the main line are polarised relays for each instrument or station that control the escapement or other means employed for rotating the type-wheel. The primary battery at each station, which is in operation only in transmitting, simply induces the currents that perform the work or control the action of the instruments. 5 claims.

CORRESPONDENCE.

Gas v. Electricity.

I beg herewith to enclose you copies of correspondence which has passed between my company and the Board of Trade, on the subject of certain damage to a gas meter, &c., and alleged to have been caused by a leakage of electricity. As the letter of the gas company to the Board of Trade was published and commented on by the gas journals before the matter was brought to the notice of my company, I should esteem it a favour if, in the interests of the industry, you would give prominence to the matter in your journal.

F. J. Walker,

General Manager and Secretary, The St. James's and Pall Mall Electric Light Company, Limited.

June 29th, 1892.

R. 4,836. Board of Trade (Railway Department), London, S.W., *May* 19*th*, 1892.

ST. JAMES'S ELECTRIC LIGHTING ORDER, 1890.

Sir,—I am directed by the Board of Trade to transmit to you, for any observations which your company may desire to offer, the accompanying copy of a letter which they have received from the Gas Light and Coke Company with regard to an alleged case of damage arising from an escape of electric current.—I am, Sir, Your obedient servant,

(Signed) R. GIFFEN.

The Secretary, The St. James's and Pall Mall Electric Light Company, Limited, Mason's Yard, Duke Street, St. James, S.W.

[COPY.]

R. 4,836. The Gas Light and Coke Company, Horseferry Road, Westminster, S.W., *May 4th*, 1892.

Sir,—The directors instruct me to enclose for your perusal the accompanying copy report of their distributing engineer in another case of damage arising from an escape of electric current.—I am, &c.

(Signed) J. O. PHILLIPS, *Secretary and General Manager.*

The Secretary, Board of Trade.

[COPY.]

R. 4,836. The Gas Light and Coke Company,
146, Goswell Road, E.C.

J. O. Phillips, Esq. *May 3rd*, 1892.

Dear Sir,—I have another case of damage to a meter and fittings by electric current in the district of the St. James's and Pall Mall Electric Lighting Company, viz., at 56, Pall Mall.

We have a 10-light *check* meter fixed at the top of w.c. in bath room on second floor near to a small cistern, the water supply pipe of which touches the back of meter, and there are electric fittings near the meter. The gas is used for heating purposes only, and is now by request of consumer temporarily dispensed with.

On the 25th ult., the occupier was startled by the noise of an explosion. The housekeeper saw smoke in the passage, and, noticing a smell of gas, at once turned the tap off at the meter. Meter and fittings are damaged, likewise the cornice and ceiling. Apparently there was a small escape of gas on consumer's fittings, and this was evidently ignited by the electric current. Our inspector informs me that he subsequently saw electricity issuing in the form of a blue spark an inch long from the electrical fittings at the point in question. The ignited gas melted the solder on the top of the meter and also the lead inlet pipe.

I cannot too forcibly call attention to the dangers these electric wires present to our fittings. They arise in such a variety of ways hitherto unsuspected by electrical engineers, and also, I apprehend, by insurance companies. The risk of fire being attributed to us when all evidence of the real cause may be effaced, is a very grave one to my mind.—I am, &c.;

(Signed) G. F. L. FOULGER,
Distributing Engineer.

Both gas and electric fittings work was executed by Messrs. Liberty & Co., of Regent Street.

The St. James and Pall Mall
Electric Light Company, Limited.

The Assistant Secretary, *May 31st*, 1892.
Railway Department,
Board of Trade, London, S.W.

ST. JAMES'S ELECTRIC LIGHTING ORDER, 1890.

Sir,—I beg to acknowledge receipt of your letter of the 19th inst., enclosing to my company a copy of a letter received by the Board of Trade from the Gas Light and Coke Company, Limited, on the subject of an alleged case of damage arising from a leakage of electric current.

On receipt of your letter, inquiry was made by this company, and the facts of the case were found to be as follows:—

The gas meter in question was placed on the top of a w.c. in the bathroom of a set of chambers at 56, Pall Mall, and was used to register the supply of gas to a stove in the sitting room, the chambers being lighted throughout by electricity.

The supply terminals of my company, with the main meter, are situated in the basement of the house, and from this point the landlord's distributing wires are carried through the house, for the supply of various sets of chambers. Although the fittings on these premises were put up a few years back, and are not of the most modern description, the insulation of the whole of the circuits in the house is in proper condition.

We learn from the landlord that, at the time of the accident complained of, the tenant of the chambers was in his sitting room with the gas stove burning, and that he heard a slight report, the stove being extinguished at the same time. No notice of this appears to have been taken for some few minutes, when on account of a smell of burning some one went into the bathroom and found the damage as described. The gas was at once shut off. In the report of the engineer of the gas company it is stated "that there was a small escape of gas on the consumer's fittings, and this was evidently ignited by the electric current. Our inspector informs us that he subsequently saw electricity issuing in the form of a blue spark an inch long from the electrical fittings at the point in question."

We are informed by the landlord that there was known to be a leakage of gas at the junction of one of the pipes to the meter, but we must protest in the strongest terms against the statement that this gas "was evidently ignited by the electric current." With regard to the "blue spark seen at the point in question," the landlord, who was present with the gas inspector at the time, explains to us that this was seen in the sitting room, where there is fitted an ordinary Edison tumbler switch. With this switch, as with most other forms, it is possible by moving the tumbler slowly across or by removing the metal cover so as to place it across the switch terminals to somewhat exaggerate the usual spark at a switch on breaking contact. We need make no further comment on this statement made by the gas company, which is put forward by them as evidence in support of a charge both rash and ill-considered.

Had the leakage of gas been fixed by an external spark as described above, the effect of an explosion would have been visible in the room.

As regards the condition of the electric circuits, the whole of the premises were tested *en bloc* for leakages on the 28th ult., in the course of the usual quarterly tests, and were found to be in order. For the purposes of our enquiry an insulation test was made on the 23rd inst. again from the consumer's terminals, and the insulation resistance of the whole of the circuits to "earth" was found to be 1·18 megohms. The electric fittings had not been altered or disturbed in any way. Apparently the damage was caused by firing back from the stove to the gas leak close to the meter, which then continued to burn.

We are informed by the landlord that he does not for a moment think of attributing the damage in any way to the electric circuit, and further, that when the officials of the gas company inspected the premises, they were accompanied by an expert engaged by them, who declared at the time in his hearing that he could see nothing in the electric light work that would account for the damage, and suggested that it would have been caused by firing back from the gas stove itself, an accident by no means improbable.

I am instructed therefore to ask, in view of the uses to which this incident has been put to prejudice the interests of the industry, that an enquiry should be held in the matter. My company is not aware as to whether Major Cardew has already made an inspection, as in the previous instance, but they would request that an early appointment be made for him to meet Prof. Kennedy, F.R.S., who has kindly consented to act for the company in this matter.

I am further directed to draw the attention of the Board of Trade to the statements contained in the copy of a paper enclosed herewith, and to point out the uses to which every purely gas accident, such as the above, will be put, unless reasonable facilities are afforded to the various electric light companies to be represented at any official enquiry, and to examine into the cause of any damage within something less than four weeks from the time of its occurrence.—I am, Sir, your obedient servant,

(Signed) F. J. WALKER,
General Manager and Secretary.

R. 5,673. Board of Trade (Railway Department),
London, S.W., *June 21st*, 1892.

ST. JAMES'S ELECTRIC LIGHTING ORDER, 1890.

Sir,—With reference to your letter of the 31st ultimo, on the subject of the damage arising from an explosion of gas at 56, Pall Mall, alleged to have been caused by a leakage of electric current, and asking that Major Cardew may be instructed to meet Professor Kennedy, F.R.S., with a view to a joint inquiry into the circumstances attending the explosion, I am directed by the Board of Trade to inform you that Major Cardew has visited the premises in question, and reported that, in his opinion, there was no evidence to establish any connection between the electric supply of your company and the small explosion of gas in question, and that in these circumstances, the Board of Trade are of opinion that no formal inquiry is necessary.—I am Sir, Your obedient servant,

(Signed) COURTENAY BOYLE.

The General Manager and Secretary,
St. James's and Pall Mall Electric Light
Company, Limited.
Mason's Yard, Duke Street, S.W.

Load Factors.

In your issue of the 24th inst. you remark in a leading article as to the vagueness and uncertainty which exists to-day as to the meaning and consequent technical use of the term "loadfactor," which, as you say, is due to Mr. Crompton, who at the time of putting it before the consideration of the Institution of Civil Engineers, gave the definition which in his work he attached to the ratio. If you will refer to the *Proc. Inst. C.E.*, Vol. cvi., page 4, you will note that:

CROMPTON.	"ELECTRICAL REVIEW."
"The load factor is the relation which the actual output of a plant of any given size bears to what would be its output if it were worked continuously day and night at *the full load* for the same period."	"The ratio of the actual output of any plant to the output it it would give if it were worked continuously, day and night, at *its* full load."

Now, Mr. Crompton seems to have been quite explicit in his meaning if not in his English. The words "*the* full load," refer not (as a demonstrative adjective "the" to the "the plant") to the full load of the plant in use, but to the observed full output load during the time under consideration, and the second definition makes this quite clear. It is very important to obtain uniformity in the use of such a term, as authors of papers do not always give their own definitions of terms used by them, and data become absolutely valueless unless reckoned from a basis "understanded of the multitude."

One more point and I shall not trespass further on your space. Why is it that by this time some uniform "lamp" cannot be taken as basis for calculations? The 50-watt seems a good size in every way, it represents practical conditions as to energy consumed, and is a common size for interior illumination, it also gives round numbers (20 per kilowatt), and can without trouble be reduced to any other size, if so desired. It would add to the utility of institution papers if some such uniformity were observed.

C. H. Yeaman.

June 25th, 1892.